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DENVER AIR POLLUTION STUDY - 1973
Proceedings of a Symposium
Volume II

ENVIRONMENTAL SCIENCES RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
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DENVER AIR POLLUTION STUDY - 1973

Proceedings of a Symposium

Volume II

Edited

by

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INTRODUCTION

The Denver Urban Plume, often referred to as the "brown cloud," is one of the area's most aesthetically unpleasing features. Although the brown cloud was observed in the early 1950's, its occurrence and severity have increased with the city's rapid population increase and urban development. It is usually associated with the Northeast section of Denver, where there is a concentration of industries, railways, freeways and a major power plant. During the late fall and winter months, when severe temperature inversions occur during periods of low wind speeds, the visible and olfactory characteristics of the cloud are easily noticed by residents throughout the metropolitan area, particularly along the South Platte River basin.

For a number of years, the composition of Denver's Urban Plume was unknown, and it became obvious that its control was impossible without a detailed study to determine its particulate and gaseous composition, and the influence of meteorological conditions. In November 1973, a coordinated effort was initiated by the U.S. Environmental Protection Agency to investigate Denver's brown cloud. Jack L. Durham, principal investigator of the project from EPA, coordinated the effort. Participants in the study included:

1. Atmospheric Aerosol Research Section, Atmospheric Chemistry and Physics Division, Environmental Sciences Research Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, N.C. (AARS-EPA)

2. University of Denver, Denver Research Institute (DRI)

3. Loren Crow, Consulting Meteorologist

4. Meteorology Research, Inc.

5. Meteorological and Air Pollution Control Commission, Colorado State Board of Health (CSBH)

6. Region VIII, U.S. Environmental Protection Agency

7. National Oceanic and Atmospheric Administration (NOAA)

8. National Center for Atmospheric Research (NCAR)

9. General Motors Research Laboratories

10. University of Washington

11. University of Texas

12. Thermo-Systems, Inc.

13. United States Army, Rocky Mountain Arsenal

14. Battelle Columbus Laboratories

15. IIT Research Institute

About fifty samplers of several different types were used to collect over 500 aerosol samples, and several types of gaseous testing equipment were used at nearly ten different locations. Meteorological data were collected at all the field laboratories and at other sites in the greater Denver area. Some of the extraordinary research conducted during the investigation included air pollution measurements from an instrumented aircraft; LIDAR observations conducted by NOAA; non-particulate organic contaminants analyzed by Battelle; radiation measurements made by NCAR; and non-volatile particulate analyses, using scanning electron microscopy/energy dispersive X-ray spectrometry, conducted by the Structures Laboratory of DRI.

Prior to the research activities, DRI was active in coordinating the preliminary efforts with EPA and the State of Colorado, in establishing monitoring sites and the sampling networks, and furnishing logistic support. During the investigation, DRI maintained the air pollution alert system, continued the logistic support, and operated its own environmental laboratory in the field.

In June 1974, preliminary results of many of the studies were published as preprints for the Air Pollution Control Association meeting. Only preliminary results were reported because of the early date required for publication and restrictive page limitations.

In March 1975, DRI, through an EPA grant, conducted a three-day symposium; comprehensive research reports from the Winter 1973 Denver Urban Plume Study were presented. Volumes I and II contain the proceedings of this symposium. DRI was responsible for the editing of the volumes. Volume III will be published at a later date.

CHARACTERIZATION OF DENVER'S URBAN PLUME USING AN INSTRUMENTED AIRCRAFT

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ABSTRACT

As part of an EPA coordinated air pollution study, an extensive three-dimensional air pollution mapping program was carried out in the Denver area during a 10-day period in mid-November, 1973. An aircraft instrumented to continuously measure scattering coefficient, condensation nuclei, O_3, NO_x, CO, SO_2, and flight parameters was used in the study. The aircraft was also equipped with instrumentation to measure the size distribution of grab samples.

The sampling pattern was designed to study the characteristics of the fresh pollutants in the morning drainage wind and those of aged pollutants in the plume later in the day. The urban plume was sampled during inversion conditions when it was trapped in a shallow mixing layer and also during periods of good mixing and ventilation.

The plume was found to be well-defined and well-mixed. High pollutant concentrations were observed aloft in power plant plumes which were subsequently ventilated to the ground as the mixing layer

deepened. Photochemical processes were found to be important, and the ozone level in the plume was found to vary from 0.00 to 0.08 ppm. The background level outside the plume was always measured at between 0.03 and 0.05 ppm. The aerosol size distribution was also found to change character as the plume aged.

INTRODUCTION

Airborne measurements of gaseous and particulate pollutants, as well as meteorological parameters affecting the pollutants, were made with MRI's Cessna 205. The aircraft was flown during a ten-day portion of a major field experiment sponsored by the Environmental Protection Agency and undertaken in the Denver area during November, 1973. Although a number of different agencies participated in the experiments, the purpose of this paper is to present selected airborne measurements and discuss these data in terms of their contribution to the understanding of the urban plume produced by Denver, Colorado.

A major emphasis of the experiment was to study the physical and chemical characteristics of Denver's urban plume and the transport processes that affect the plume. In particular, the choice of both the airborne sampling paths and ground site locations were made to best study the aging processes that take place in the plume.

Previously, Riehl and Herkhof[1,2], Crow[3], and Riehl and Crow[4] have reported meteorological factors that affect air quality in the Denver area. We are unaware of any previous airborne measurements made on the Denver plume. Similar work, however, has been done in other areas such as St. Louis[5,6,7].

Description of the Program

The MRI aircraft as described by Blumenthal and Ensor[8] has been used extensively to measure the three-dimensional distribution of air pollutants. The sampling instrumentation used in the aircraft for the Denver study included fast time response monitors for O_3, NO_x, SO_2, CO, condensation nuclei, scattering coefficient, temperature, relative humidity, turbulence, altitude, and position. In addition, measurements of the size distribution of grab samples were made by installing a TSI Model 3030 electrical aerosol size analyzer in the plane. Liu et al. [9] have described the use of such an instrument for the measurement of submicron aerosol size distributions, and Liu and Piu[10] have performed an extensive calibration of the instrument. The size distributions were obtained in the aircraft by rapidly filling a large plastic bag (about 60 liters) to obtain the grab sample and then immediately analyzing the aerosol in the bag with the size analyzer, as described by Sem.[11]

Blumenthal[12] has described considerations for plume sampling as being dependent on the specific objectives of the particular study. One of the dominant meteorological factors in the Denver area is the drainage flow that normally exists during the morning hours. This flow carries the urban pollutant discharge northeast along the Platte River Valley. Thus, to optimize sampling, horizontal traverses and spirals were made at the points shown in Figure 1. Traverses at various altitudes were made along the routes marked I, II, or III and spirals were made at Standley Lake, Henderson, and near the EPA trailer location. Both the Henderson and EPA spiral locations were chosen because of ground measurements being made at these points and their close proximity to the expected plume centerline. The Standley Lake spiral was normally made to obtain useful background data. Unfortunately, sampling path II had to be terminated at Interstate 80S since flights over the Rocky Mountain Arsenal were prohibited.

Upper level wind data were obtained at both Arvada and the EPA trailer using pilot balloons (pibals). These data, as well as summaries of surface wind data, have been used in this paper and are based on information collected during the study and reported by Crow[13]. Other data, including portions of the gas and b_{scat} data that were obtained at the EPA trailer and reported by Durham et al.,[14] were also used to support the conclusions arrived at in this paper.

Experimental Results

Aircraft sampling was performed a total of six days in November, 1973. Data from three of these days are presented here to illustrate various urban plume phenomena.

November 20 - Urban Plume Structure

November 20 represents an excellent reference point to begin an air pollution episode. A snowstorm invaded the Denver area during

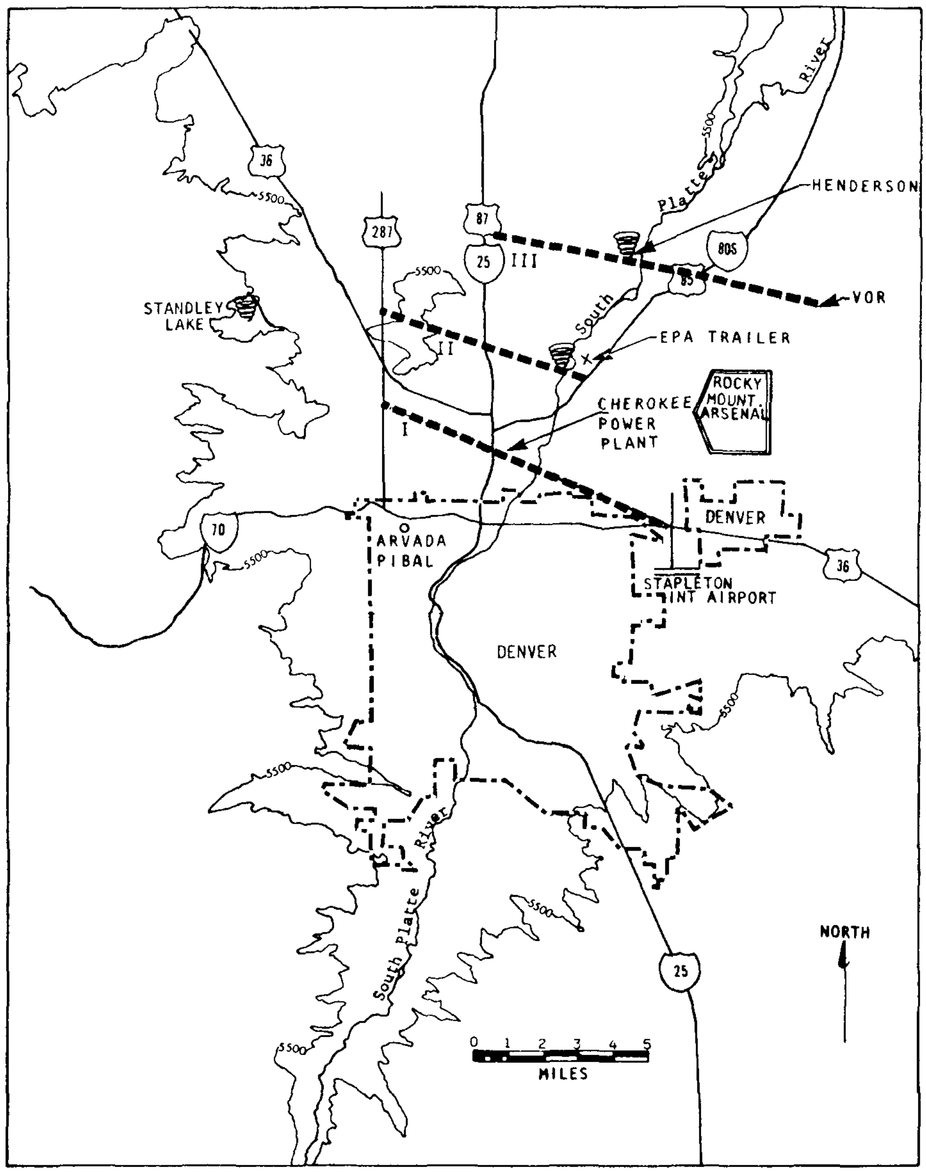

Figure 1. Denver and the surrounding area. Sampling paths and spiral locations are shown.

the afternoon of the 19th and lasted until the early morning hours of the 20th. Surface winds for the 20th were generally from the south throughout the day, and thus the plume consisted of fresh pollutants which aged as they traveled northward. The freshly cleaned air mass outside the plume and the relatively constant net flow produced an almost ideal sampling situation and a plume with a fairly simple structure. Figure 2 indicates the streamlines at 11:00 a.m., as well as an outline of the urban plume as determined by horizontal traverses and photographs.

Figure 3 shows a cross section of the plume obtained at 6200 ft msl along sampling route II (see Figure 1) from Highway 287 to Highway 80S at about 10:00 a.m. A distinct increase in NO_x, CO, and scattering coefficient at approximately the 1.5 mile point indicates the western edge of the urban plume. A further increase in NO_x, SO_2, and scattering coefficient and a slight decrease in ozone at the 4.5 mile point probably indicate penetration of the bottom edge of the Cherokee power plant plume. The decrease in O_3 is due to scavenging of ozone by freshly emitted NO.

Figure 4 is a vertical profile taken near the EPA trailer at 10:55, an hour after the cross section in Figure 3. The temperature profile indicates a slightly stable lapse rate with a weak inversion starting at 6400 ft msl (about 1200 ft above ground). Up to about 5800 ft msl, the various pollutants are well mixed and occur in about the same concentrations as were seen throughout the urban plume cross section shown in Figure 3. Between 5900 ft and 6600 ft msl, however, the power plant plume is superimposed on the urban plume in a distinct, well-defined layer, the power plant plume being confined by the weak inversion layer.

Characteristics of the power plant plume include high levels of primary pollutants such as NO_x, SO_2, and particulates and a very low level of ozone due to scavenging by NO. This type of layer aloft containing high concentrations of pollutants (in this case $NO_x > 0.5$ ppm) can persist for long periods of time and can be transported many miles before being ventilated to the ground when finally entrained by a deepening mixing layer.

Above the inversion at about 6700 ft msl, the pollutant levels drop off to virtually clean air values. Note, however, that the ozone level is approximately 0.04 ppm. This level has been observed in many areas of North America in very clean air and often represents the ozone background level.[15] In the urban plume below the power

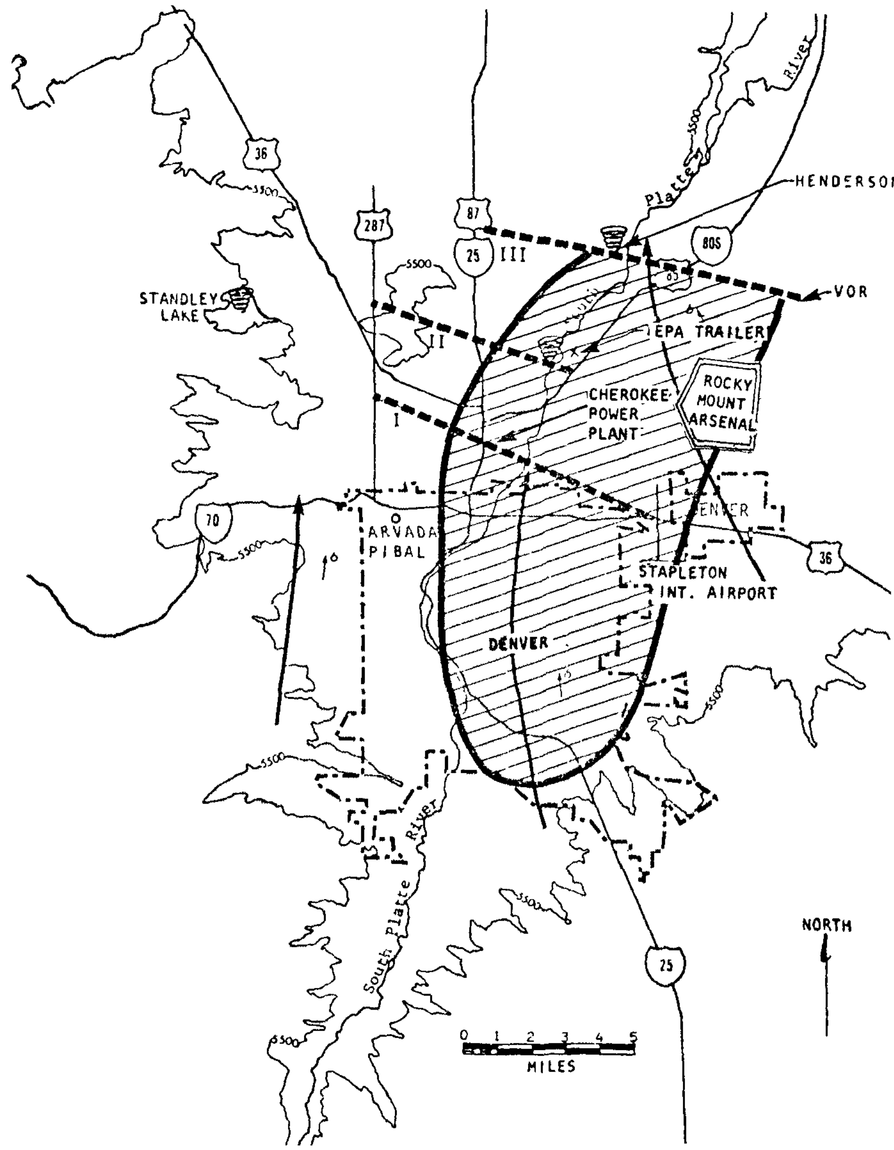

Figure 2. Streamline analysis and location of urban plume, November 20, 1973, 1100 MST.

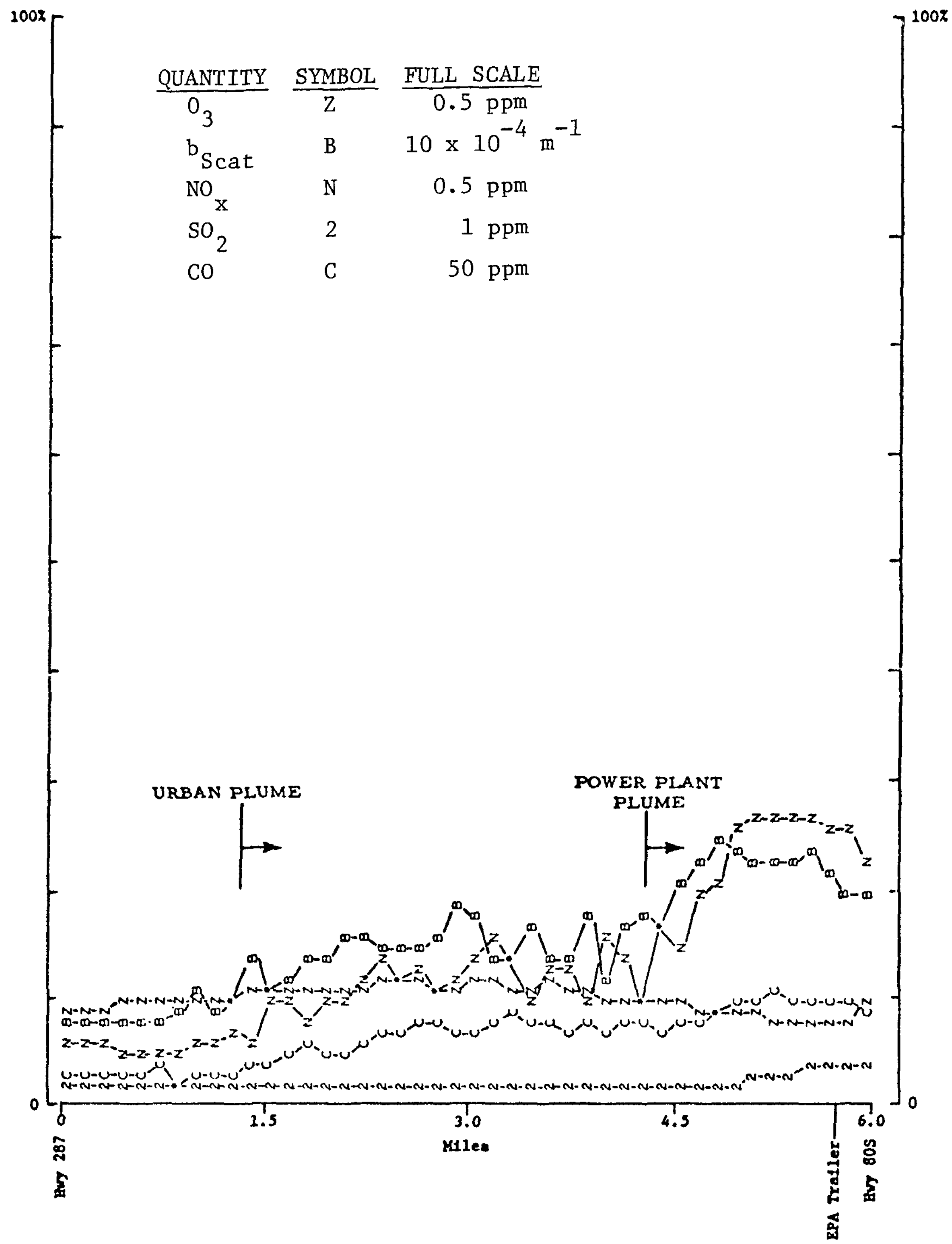

Figure 3. Cross section of Denver urban plume at 6200 ft msl along Sampling Route II. November 20, 1973, 1000 MST.

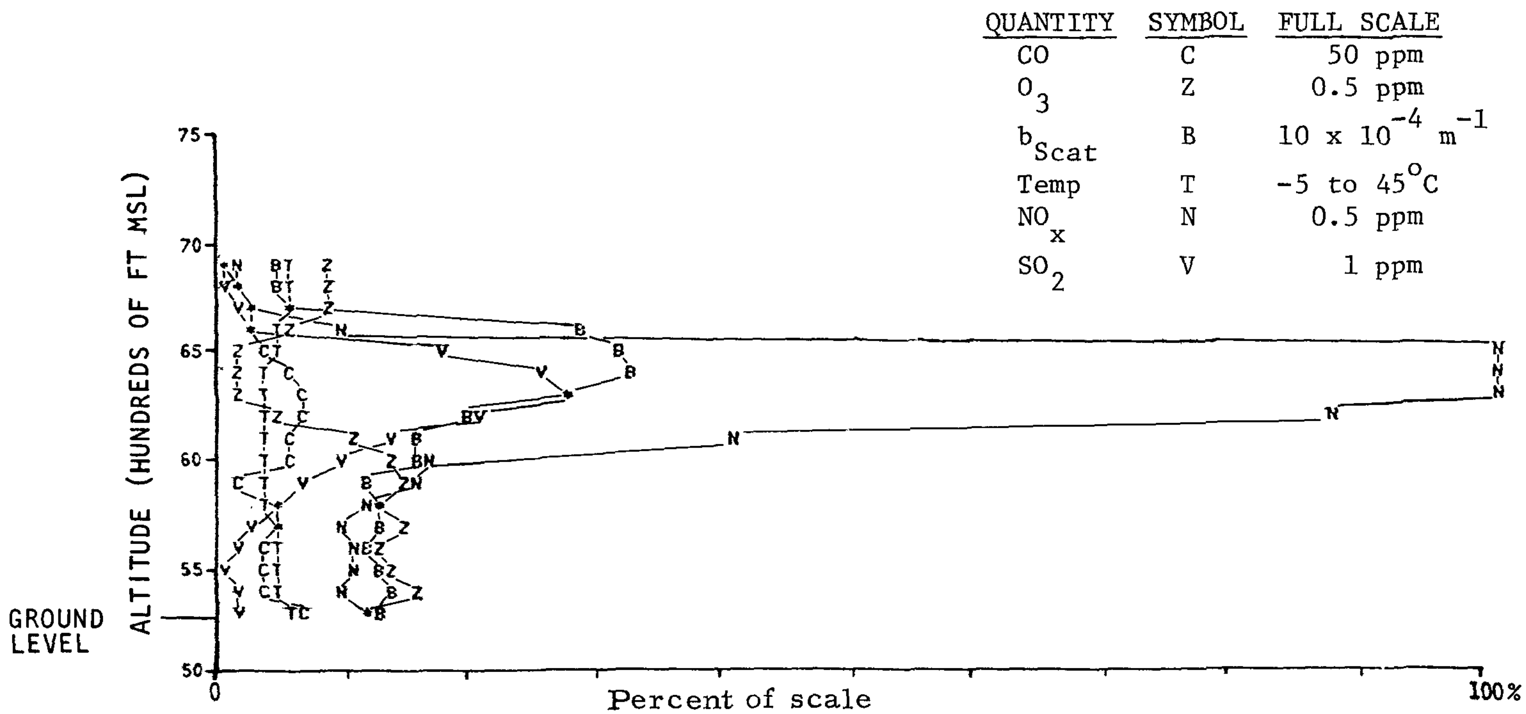

Figure 4. Vertical profile near the EPA trailer. November 20, 1973, 1055 MST.

plant plume, the ozone level is considerably higher than the background level, indicating photochemical production of ozone.

Figure 5 is a vertical profile taken in the urban plume at Henderson shortly before the one in Figure 4. Since the power plant plume seen in Figure 4 was not directly over Henderson at this time, no indication of it is seen in the profile. The temperature profile at Henderson indicates a slightly stable lapse rate with a weak inversion beginning at 6200 ft msl, about 200 ft lower than the one at the EPA trailer. The higher inversion level at the EPA trailer may be an indication of the urban heat island effect.

The pollutant levels measured in the urban plume at Henderson are similar to those presented earlier and indicate a plume which is well-mixed, both horizontally and vertically. The plume at Henderson is fairly uniform in concentration up to a level of about 5900 ft where mixing is impeded and concentrations start to drop off, reaching clean air values near 6400 ft.

Figure 6 is a vertical profile of the urban plume over the EPA trailer at about 2:00 p.m. The wind is still from the south. Due to surface heating, the mixing layer has deepened, yet pollutants are still confined to a layer about 2000 ft thick. The power plant plume is no longer well-defined on this or other afternoon traverses and has evidently been entrained in the surface mixing layer. Integration throughout the mixing layer shows that the total pollutant budget is clearly higher than during the morning flight reflecting the entrainment of the power plant plume and the overall accumulation of pollutants during the day. It is interesting to note that photochemical processes are active, even at temperatures of 0°C, and that the ozone level in the mixing layer is approximately equal to the ambient air standard of 0.08 ppm.

The data from November 20 verify several statements made by Riehl and Herkhof.[2] In a discussion of turbulent transport, they surmise that "during daytime, the polluted layer must extend well above 100 m with characteristics almost those of a mixed layer." Figures 4, 5, and 6 indicate that, at least on November 20, the polluted layer was well mixed during the day and extended up to about 900 ft (or 300 m) in the morning and to 2000 ft (or 650 m) by midafternoon. Similar characteristics were also observed on other days. In addition, they conclude that "non-persistence of a temperature inversion through the noon hours is not a good guide for current and subsequent air pollution levels." Figures 5 and 6 indicate the

QUANTITY	SYMBOL	FULL SCALE
CO	C	50 ppm
O_3	Z	0.5 ppm
b_{Scat}	B	$10 \times 10^{-4}\ m^{-1}$
Temp	T	-5 to 45°C
NO_x	N	0.5 ppm
SO_2	V	1 ppm

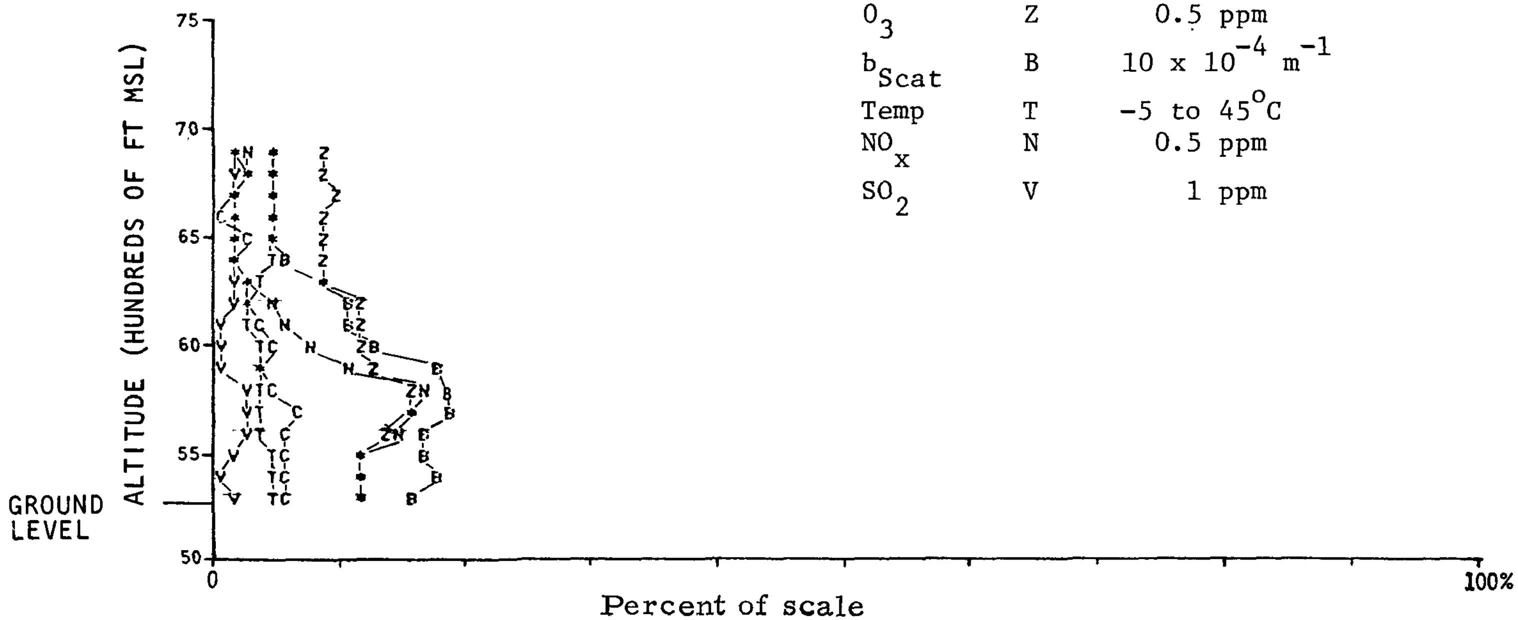

Figure 5. Vertical profile at Henderson. November 20, 1973, 1047 MST.

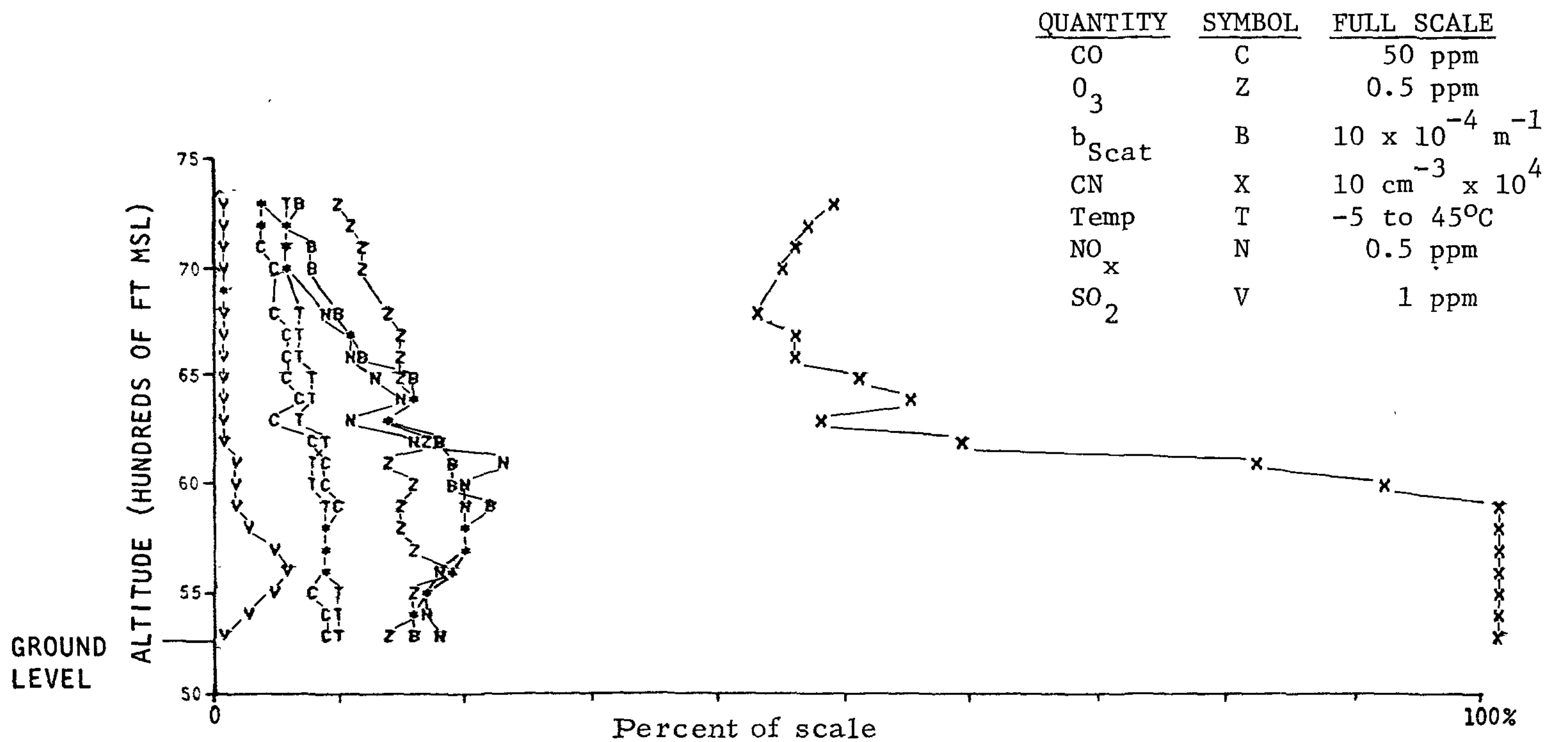

Figure 6. Vertical profile near the EPA trailer. November 20, 1973, 1400 MST.

problem associated with using the inversion level to predict the depth of the mixed layer and thus to some extent the surface concentrations. Using the inversion level in Figure 5 as a guide to mixing depth would lead to an assumed mixing layer height of 6200 to 6400 ft msl or 1000 to 1200 ft above ground level. Using the actual pollutant concentrations as an indicator of mixing layer height leads to an actual mixing depth of only 600 to 800 ft. In Figure 6, no significant inversion is indicated, yet the pollutants are reasonably well-confined to a layer about 2000 ft deep.

November 21 - Pollutant Characteristics in the Urban Plume

November 21 represents the second day of an episode which began during the morning hours of November 20. During the late afternoon and evening of November 20, winds were light and variable and a strong radiation inversion developed. Thus, pollutant levels increased over the city. The morning of November 21 was similar to that shown in Figure 2. By late morning, the wind field had started to shift to an easterly flow, and shortly after noon the wind speed increased abruptly to a strong flow from the east, moving the pollutants up against the foothills to the west of Denver.

Figure 7 is a vertical profile taken at 0925 MST near the EPA trailer site. Figure 8 is another profile taken at the same location at 1242 MST. Figure 7 shows a dense polluted urban plume trapped beneath a strong radiation inversion with clean air above the mixing layer. At this time, photochemical production of ozone within the mixing layer had not yet exceeded the scavenging of ozone by freshly emitted NO or by NO which had accumulated overnight. The ozone level in the mixing layer was thus depressed from the clean air level above.

Figures 9 and 10 illustrate in more detail the character of the urban plume during the morning. The figures show aerosol size distributions obtained at the low point of the spirals shown in Figures 7 and 8, respectively. Both surface and volume distributions are plotted, along with the number distribution.

Whitby and his associates[16,17] have shown that combustion sources generate fresh aerosol in the size range under 0.1 μm diameter. However, as the aerosol ages and photochemical generation of new aerosol material occurs, the size distribution will shift,

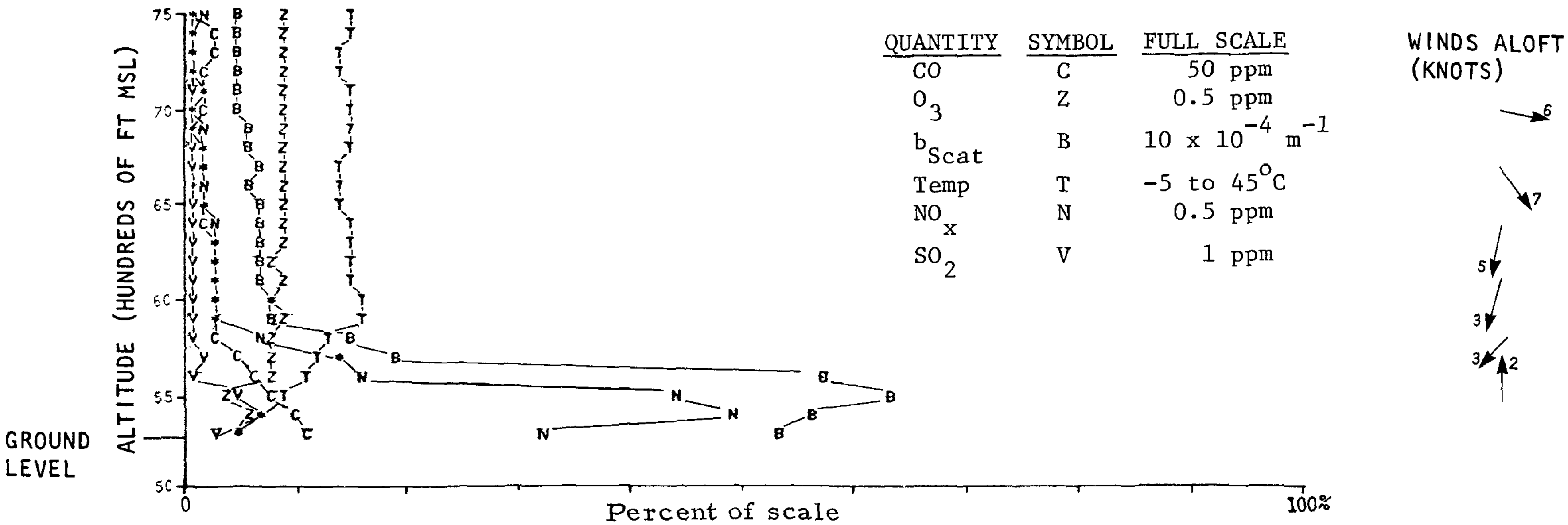

Figure 7. Vertical profile near the EPA trailer. November 21, 1973, 0925 MST.

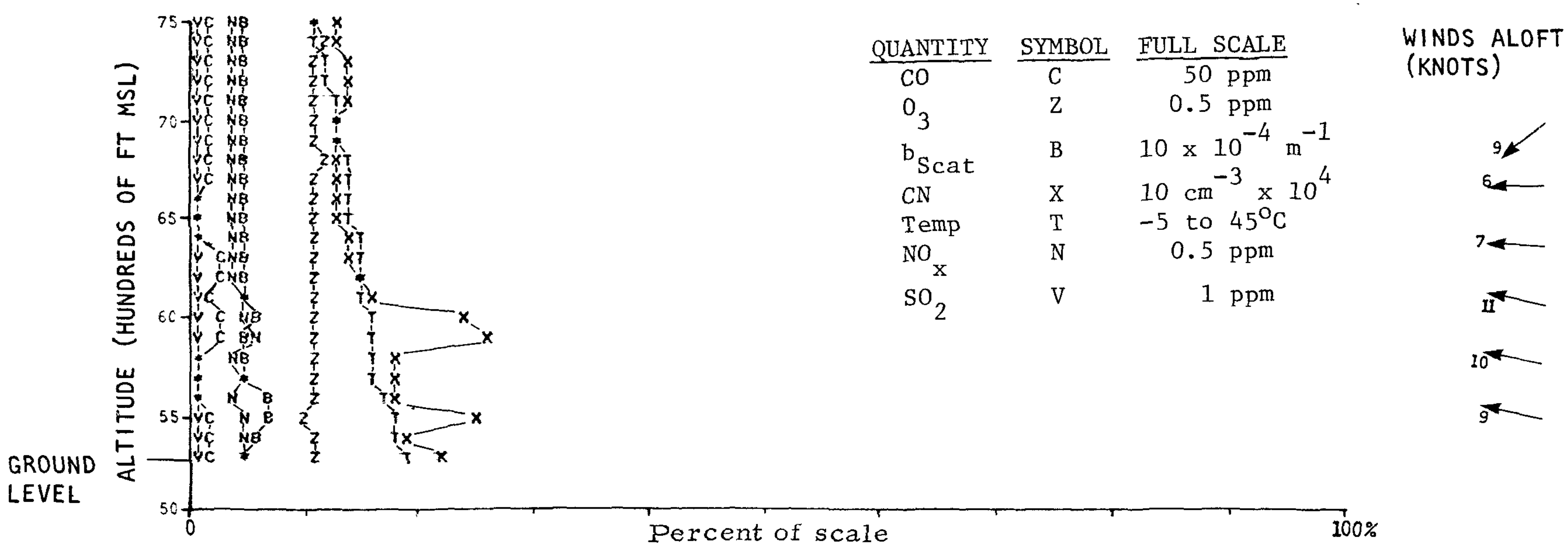

Figure 8. Vertical profile near the EPA trailer. November 21, 1973, 1242 MST.

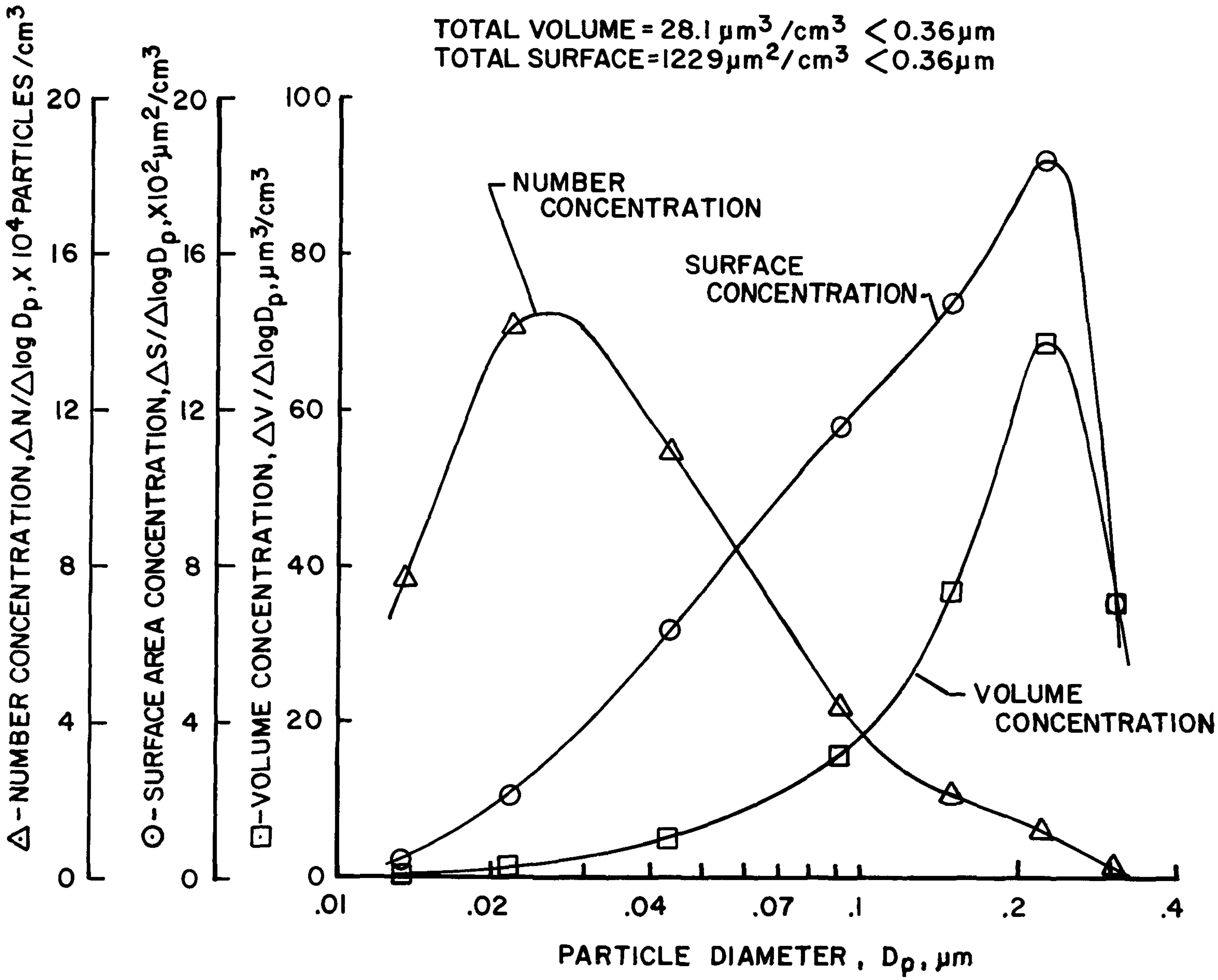

Figure 9. Size distribution of aerosol obtained at lowest point of spiral near EPA trailer (see Figure 7). November 21, 1973, 0925 MST.

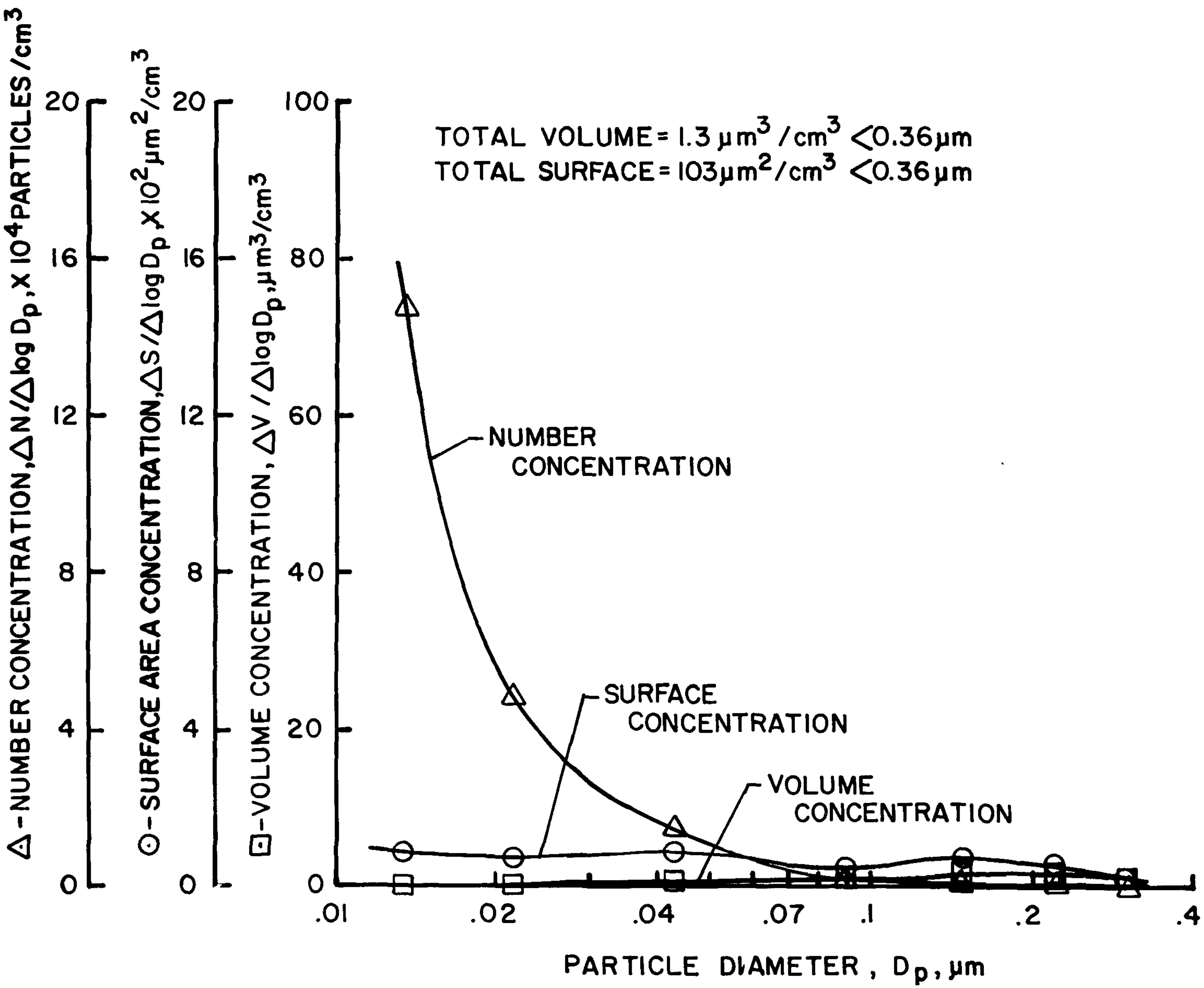

Figure 10. Size distribution of aerosol obtained at lowest point of spiral near EPA trailer (see Figure 8). November 21, 1973, 1242 MST.

and the aerosol will coagulate and accumulate in the 0.1-1 μm diameter size range. This process is accelerated if the fresh combustion aerosol is emitted into a background of aged polluted air already containing large amounts of particulates in the 0.1-1 μm size range.

The surface distribution shown in Figure 9 includes both a large peak at 0.25 μm diameter (called the "accumulation mode" by Whitby) and a much smaller inflection in the distribution at 0.07 μm diameter. This indicates that the morning urban plume at this location consists of a mixture of well-aged pollutants accumulated overnight plus a small amount of freshly emitted effluents.

By the time the 1242 MST sounding (Figure 8) near the EPA trailer was made, the wind shift mentioned earlier had occurred. Cleaner, rural air had replaced the urban plume existing at this location earlier in the day (0925 MST, see Figure 7). In Figure 8, the ozone level is at a clean air value, other pollutant levels are quite low, and the temperature inversion has disappeared. The surface area distribution shown in Figure 10 indicates a small amount of fresh combustion aerosol from an unidentified source nearby, but no large "accumulation" mode is present.

Figure 11 is a profile taken over Standley Lake at 1134 MST. This profile shows the change in character of the urban plume as it ages. The air in the mixing layer had probably traveled north from Denver and then moved westward with the wind shift. It had thus had a chance to age for a few hours since passing over a concentrated source area. The profile was taken before the abrupt increase in wind speed and an inversion layer is still present. The mixing layer has deepened since the morning sounding due to surface heating, but the plume is still confined within a layer about 1000 feet deep.

Primary pollutants such as CO, SO_2, and NO_x have remained at relatively high values; but ozone, a secondary pollutant, has now increased above the clean air value, equalling the Federal ambient air standard of 0.08 ppm in places. Figure 12 is a size distribution obtained at the bottom of the spiral shown in Figure 11. A well developed "accumulation" mode is seen with little evidence of fresh combustion aerosol.

Thus, as the urban plume ages in the absence of fresh emissions and in the presence of sunlight, the aerosol size distribution shifts to the "accumulation" mode, the rate of production of

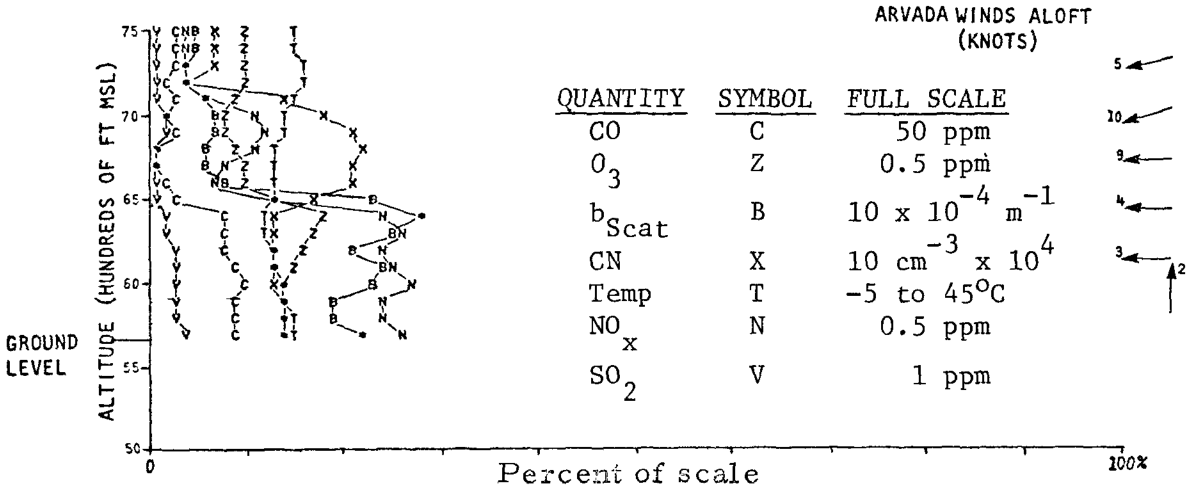

Figure 11. Vertical profile over Standley Lake. November 21, 1973, 1134 MST.

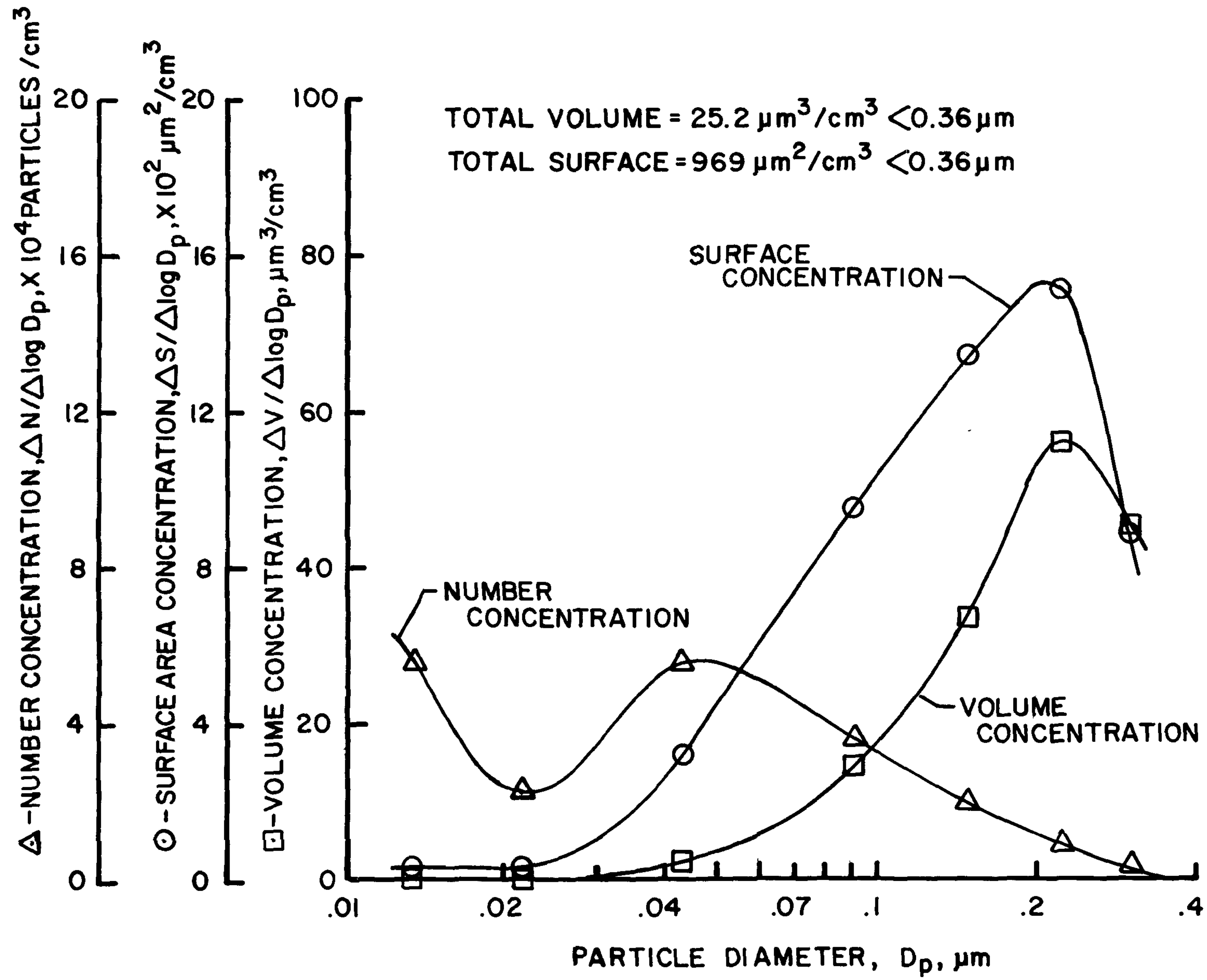

Figure 12. Size distribution of aerosol obtained at lowest point of spiral over Standley Lake (see Figure 11). November 21, 1973, 1134 MST.

ozone surpasses the rate of scavenging, and the ozone level increases. Although it was not measured independently by the aircraft, the EPA van data shows that, as the plume ages, the NO_x shifts from being mostly NO to mostly NO_2. This is consistent with the increase in the ozone level.

Riehl and Herkhof[2] in their studies had assumed that aerosol mass was a good indicator of the source strength of the city and that it was a conservative quantity. It is evident from our results that photochemical processes occur in the Denver area, and that the size distribution in the plume changes with time. One must use caution when assuming that aerosol mass or other aerosol parameters are conservative quantities since photochemical production of aerosol is a definite possibility.

November 15 - Urban Plume Structure

During the afternoon and evening of November 14, strong synoptic westerly winds swept the Denver area clean of existing pollutants. The winds continued through the early morning hours (1:00 -5:00 a.m.) of the 15th; however, by 7:00 a.m., the surface winds reported at Stapleton Airport were 210° at 6 knots. Stapleton continued to report southerly winds at less than 10 knots until 11:00 a.m. Although upper level winds were not recorded on the 15th, it is evident that urban emissions were quickly transported from the area during the early morning hours. As synoptic influences lessened, pollutant transport became more dependent on local flow patterns. Thus, the drainage flow that developed after 5:00 a.m. moved a fresh urban pollutant discharge northeast along the Platte River Valley. Shortly after 11:00 a.m., the drainage flow was interrupted as the winds increased and became more easterly, moving the pollutants up against the foothills to the west of Denver.

Figures 13 through 16 show comparisons of vertical soundings and size distribution data at Henderson and near the EPA trailer location. The vertical profile near the EPA trailer at 9:39 a.m. is shown in Figure 13. Two penetrations of the Cherokee power plant plume (6000 and 6400 ft msl) during the sounding are indicated by the increased levels of NO_x and SO_2, with reduced levels of ozone due to scavenging by NO. The urban plume beneath the base of the power plant plume was composed primarily of fresh pollutants. Although some aging has occurred, Figure 15, "A size distribution at the bottom of the profile," shows that about 65 percent of the surface

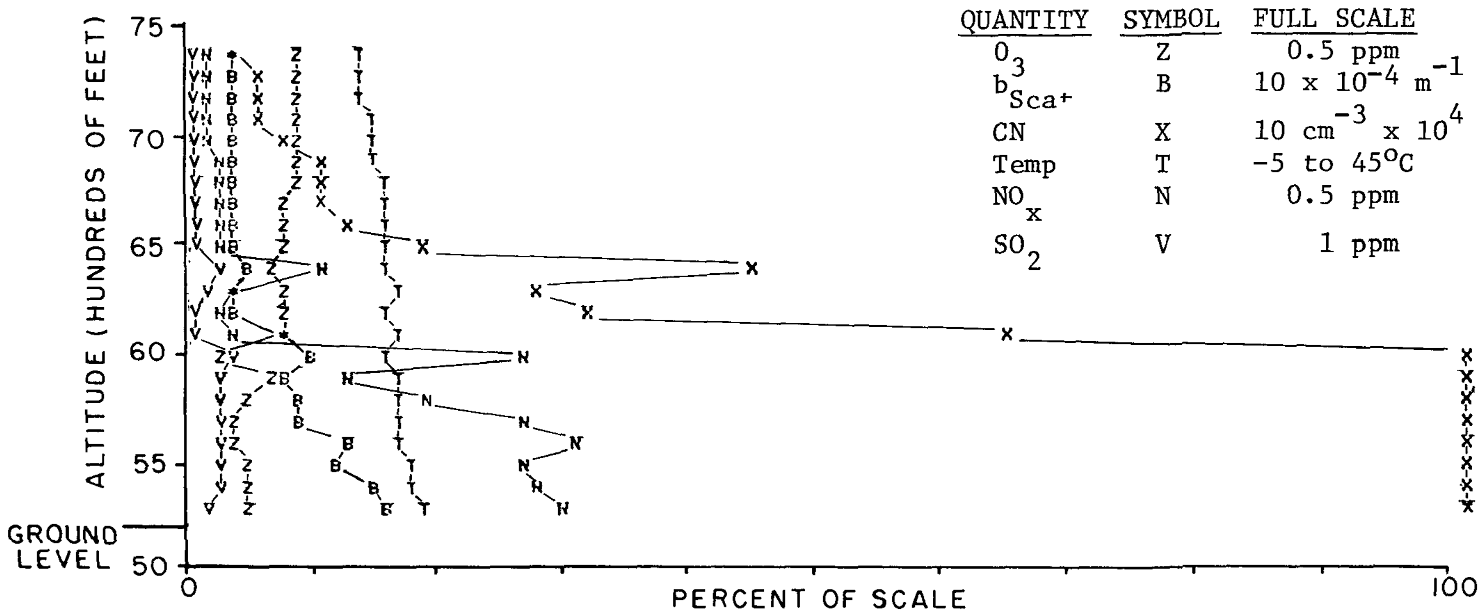

Figure 13. Vertical profile near the EPA trailer. November 15, 1973, 0939 MST.

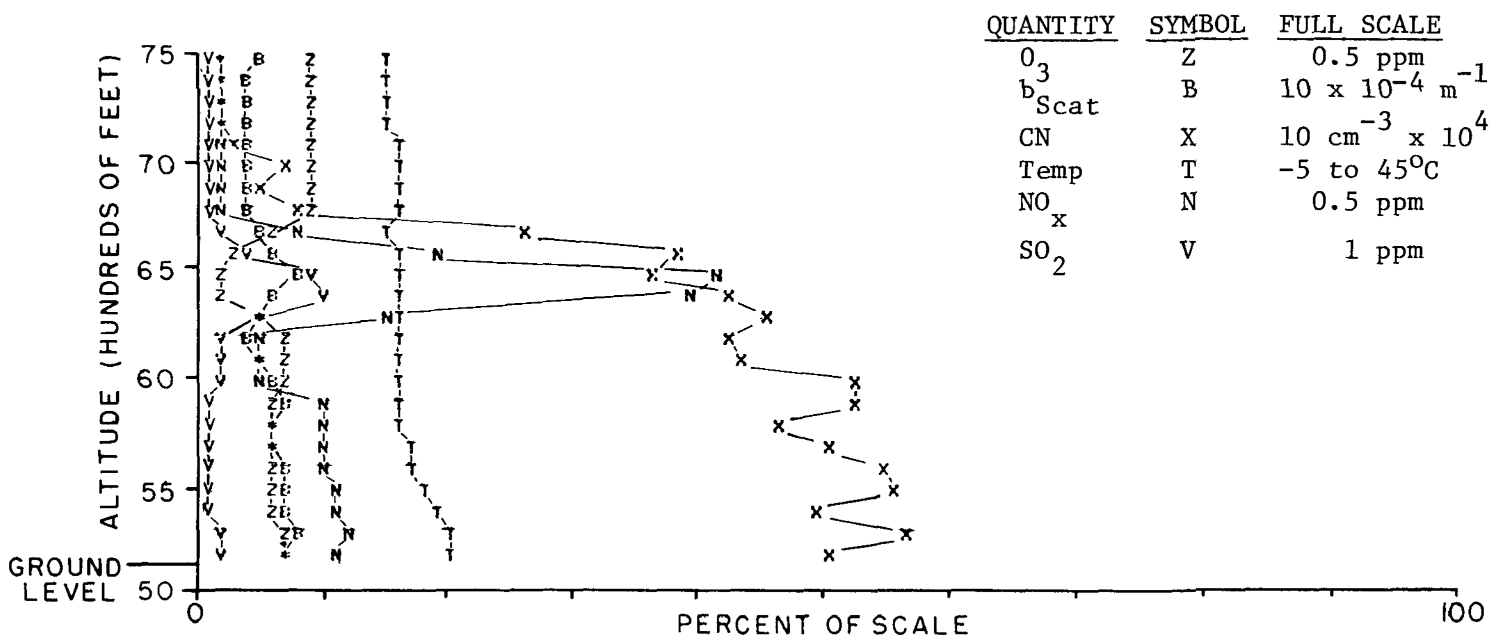

Figure 14. Vertical profile at Henderson. November 15, 1973, 0927 MST.

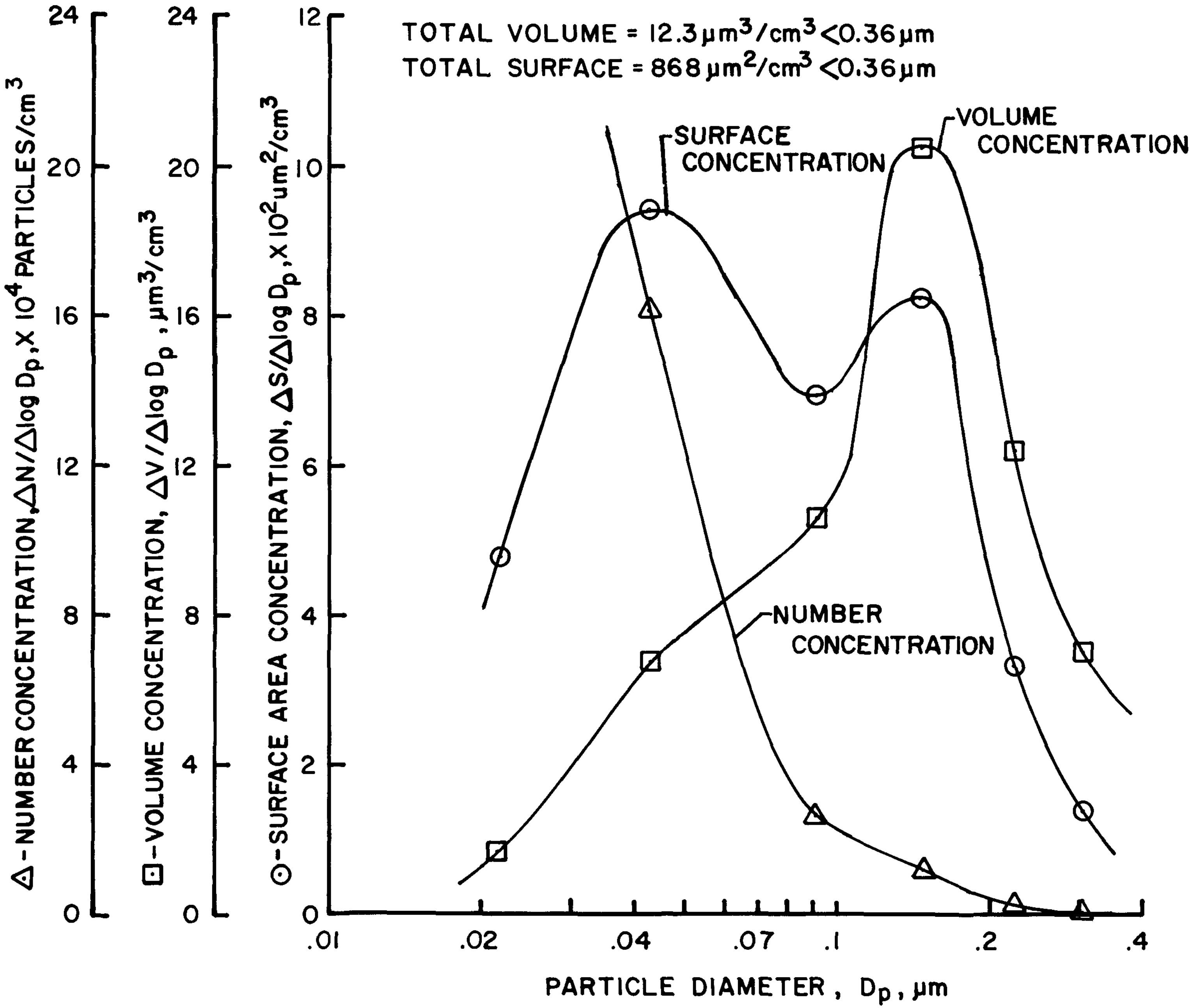

Figure 15. Size distribution of aerosol obtained at lowest point of spiral near EPA trailer (see Figure 13). November 15, 1973, 0939 MST.

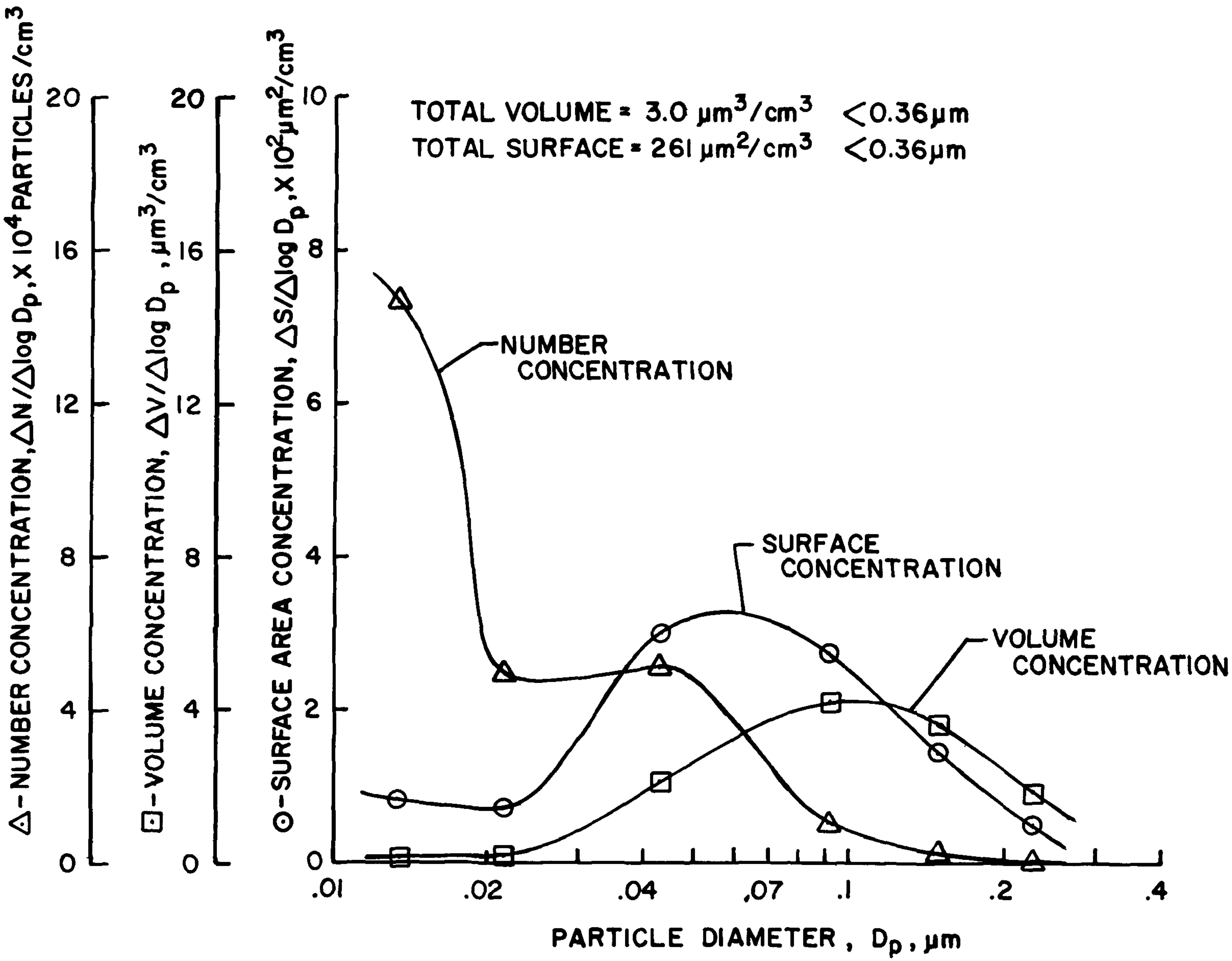

Figure 16. Size distribution of aerosol obtained at lowest point of spiral at Henderson (see Figure 14). November 15, 1973, 0927 MST.

area concentration appears to have been fresh aerosol with a mode at 0.04 μm. The age of the urban plume is also indicated by the reduced level of ozone within the mixed layer. The depletion is due to the scrubbing action of NO, indicating that much of the measured NO_x is the result of recent emissions. The temperature profile indicated a slightly unstable lapse rate from the surface to 5600 ft msl. From 5600 to 6800 ft msl, the lapse rate was nearly isothermal, and above 6800 ft less stability existed. No significant inversions were recorded during the profile.

The Henderson profile and the size distribution obtained at the low point of the profile are shown in Figures 14 and 16. The power plant plume is above the urban plume and is trapped in an isothermal layer that extends from 5800 to 7100 ft msl. The associated NO_x, O_3, and SO_2 concentrations in the power plant plume indicate that the sounding was made closer to the plume centerline than during the EPA sounding. The strong deficit of ozone implies the presence of fresh NO in the plume.

Integration of NO_x through the mixed layer (surface to 6000 ft msl) shows that the urban pollutants at Henderson are about half of those measured at the EPA trailer location. This reduction is also evident in the aerosol volume and surface distributions for the two sites. At the trailer location, the total volume = 12.3 $\mu m^3/cm^3 < 0.36$ μm and the total surface = 868 $\mu m^2/cm^3 < 0.36$ μm, while at Henderson the total volume = 3.0 $\mu m^3/cm^3 < 0.36$ μm and the total surface = 261 $\mu m^2/cm^3 < 0.36$ μm. Considering the air mass history, it is reasonable to expect that the leading edge of the morning urban pollutant discharge was just reaching Henderson at the time of the profile. Photographs and visual observations during the flight support the measurements.

Evidence of aging in the urban plume measured during the Henderson profile is apparent. Figure 14 shows that the ozone concentrations have increased while the condensation nuclei values are nearly half of what was measured in the urban plume during the profile near the EPA trailer. The CN concentrations indicate the presence of some fresh pollutants. In Figure 16, the number distribution also indicates the presence of some fresh combustion or photochemical aerosol, but the surface and volume distributions indicate that the aerosol is primarily aged.

The urban plume seen in the Henderson profile is well-mixed up to 5900 ft msl, at which point pollutant concentrations begin to decrease. It is obvious that the power plant plume has not been entrained at this location in the well-mixed urban plume below it. Above 6800 ft msl, the ozone has reached the clean air value of 0.04 ppm.

Figures 17, 18, and 19 show horizontal traverses made by the aircraft along sampling route III (see Figure 1), while Figure 20 is a size distribution obtained during the 6000 ft msl traverse shown in Figure 17. The traverses were made between 8:41 a.m., and 9:08 a.m., prior to the soundings shown in Figures 13 and 14. In Figure 17, the power plant plume near Henderson is easily identified by the high NO_x and SO_2 concentrations along with the absence of ozone. The distinct increase in NO_x and scattering coefficient to the west of the power plant plume are indications of a portion of the urban plume. Although not positively identified, the NO_x, SO_2, scattering coefficient, and ozone to the east of Henderson, as seen in Figures 17, 18, and 19, are most probably due to the power plant plume rather than the urban plume.

The concentrations to the east of Henderson are believed to be associated with the power plant plume because:

1. Figure 14 shows that the urban plume was mixed from the surface to 5900 ft msl, but the profile was made nearly 45 minutes after the traverse shown in Figure 17. It is reasonable to expect the mixing depth would increase rather than decrease as surface heating took place. Therefore, the urban plume should have been trapped at 5900 ft msl or lower during the time the traverse was being made;

2. The 6500 ft msl traverse shown in Figure 18 again shows the power plant peak, identified by the NO_x, SO_2, and ozone concentrations, to be located near Henderson. Since the terrain to the east along the sampling path is lower than to the west, and since the plane was above the urban concentrations that were seen to the west during the 6000 ft msl traverse, it is reasonable to assume the plane would also be sampling above the urban plume during the eastern portion of the 6500 ft msl traverse. The same logic applies for the 7000 ft msl traverse shown in Figure 19; and

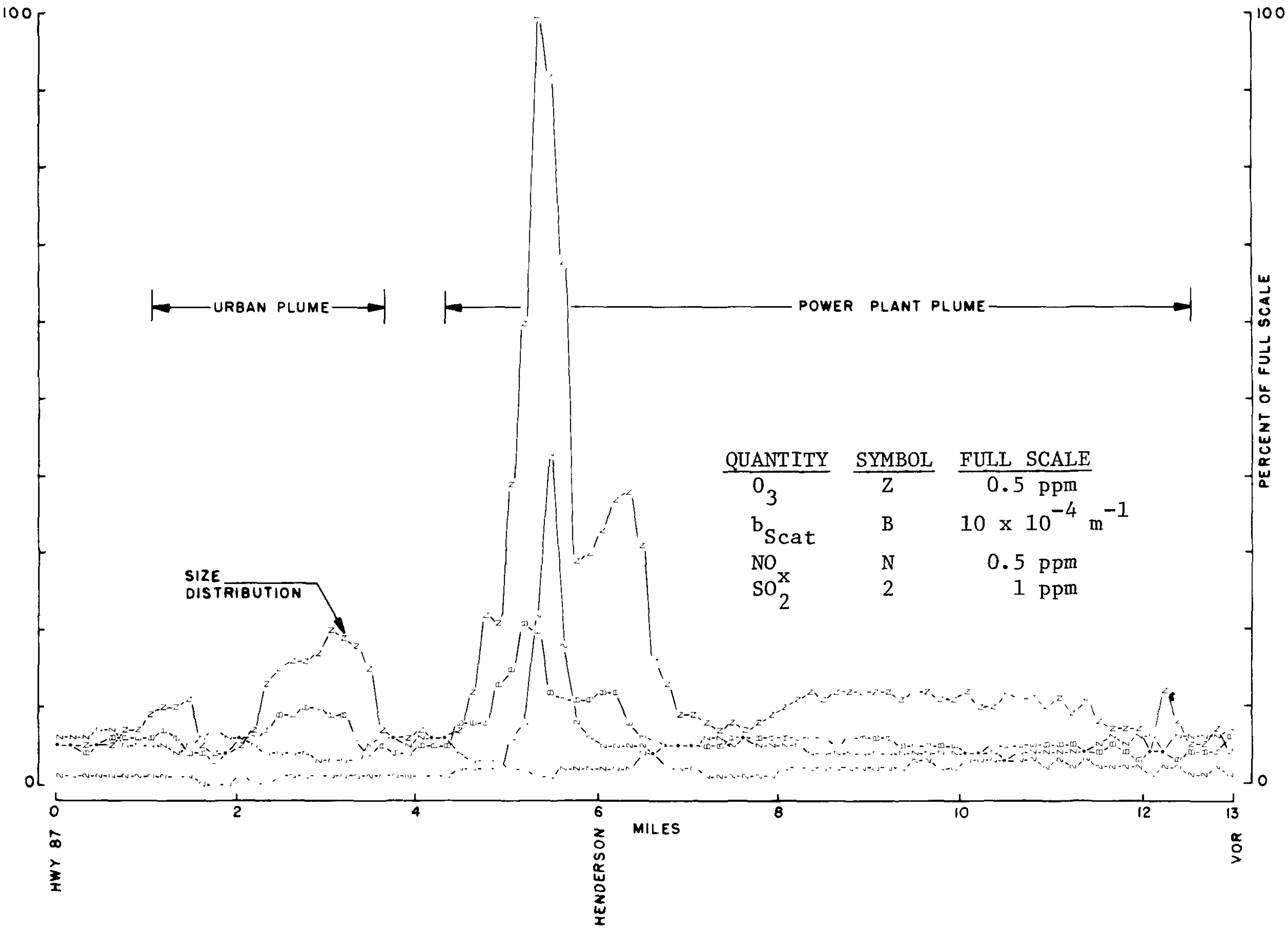

Figure 17. Sampling traverse at 6000 ft msl along sampling route III. November 15, 1973, 0844 MST.

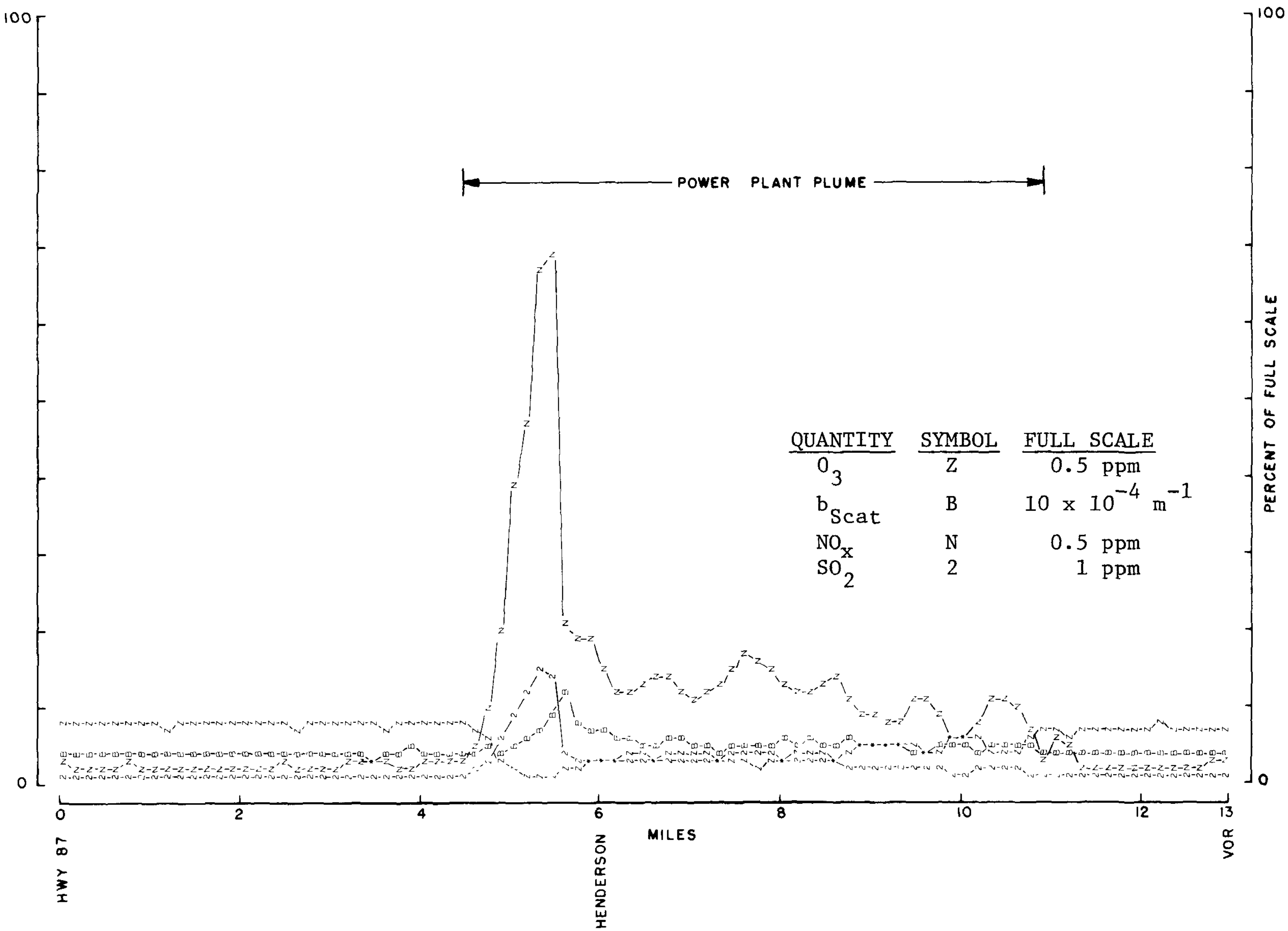

Figure 18. Sampling traverse at 6500 ft msl along sampling route III. November 15, 1973, 0855 MST.

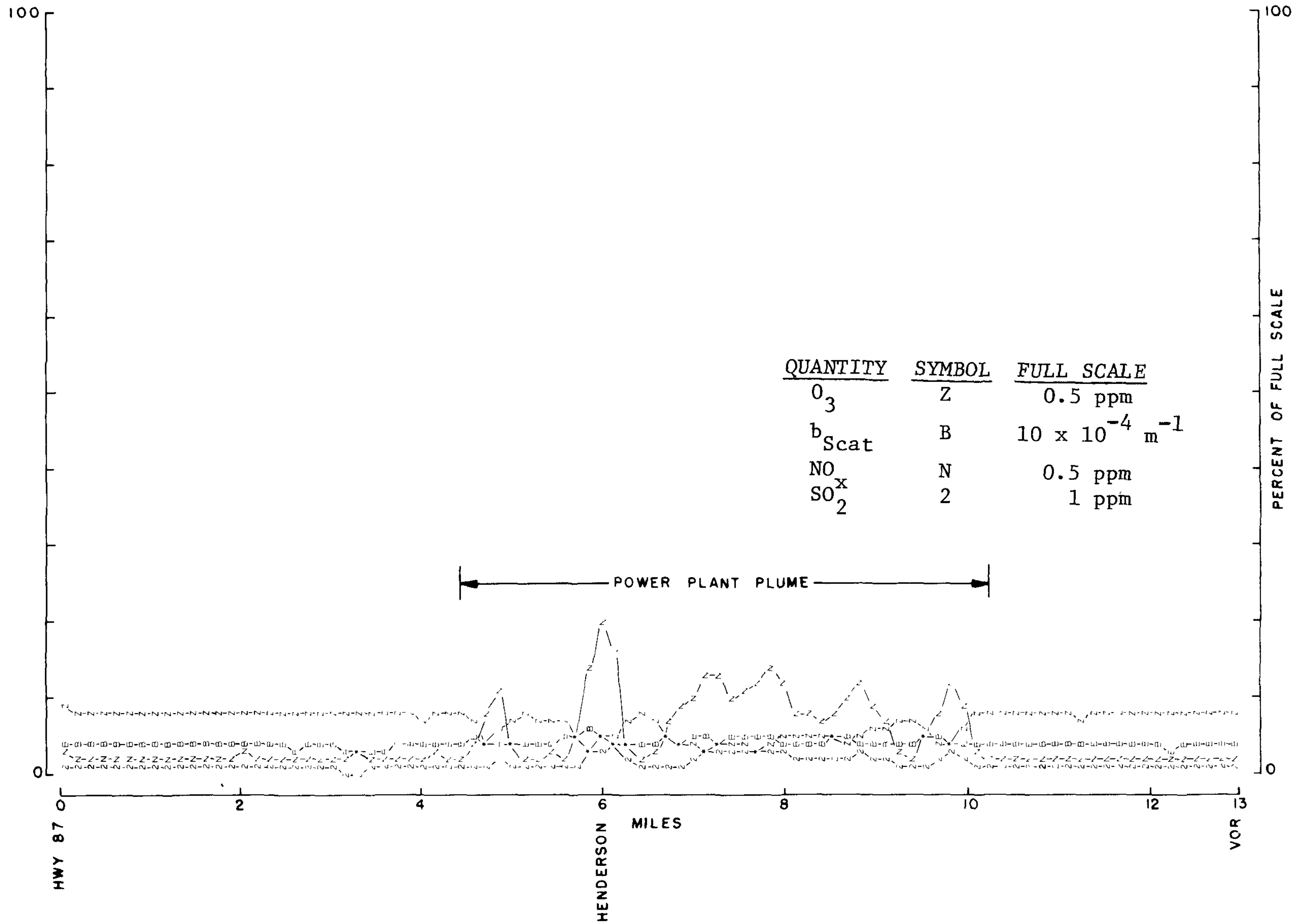

Figure 19. Sampling traverse at 7000 ft msl along sampling route III. November 15, 1973, 0904 MST.

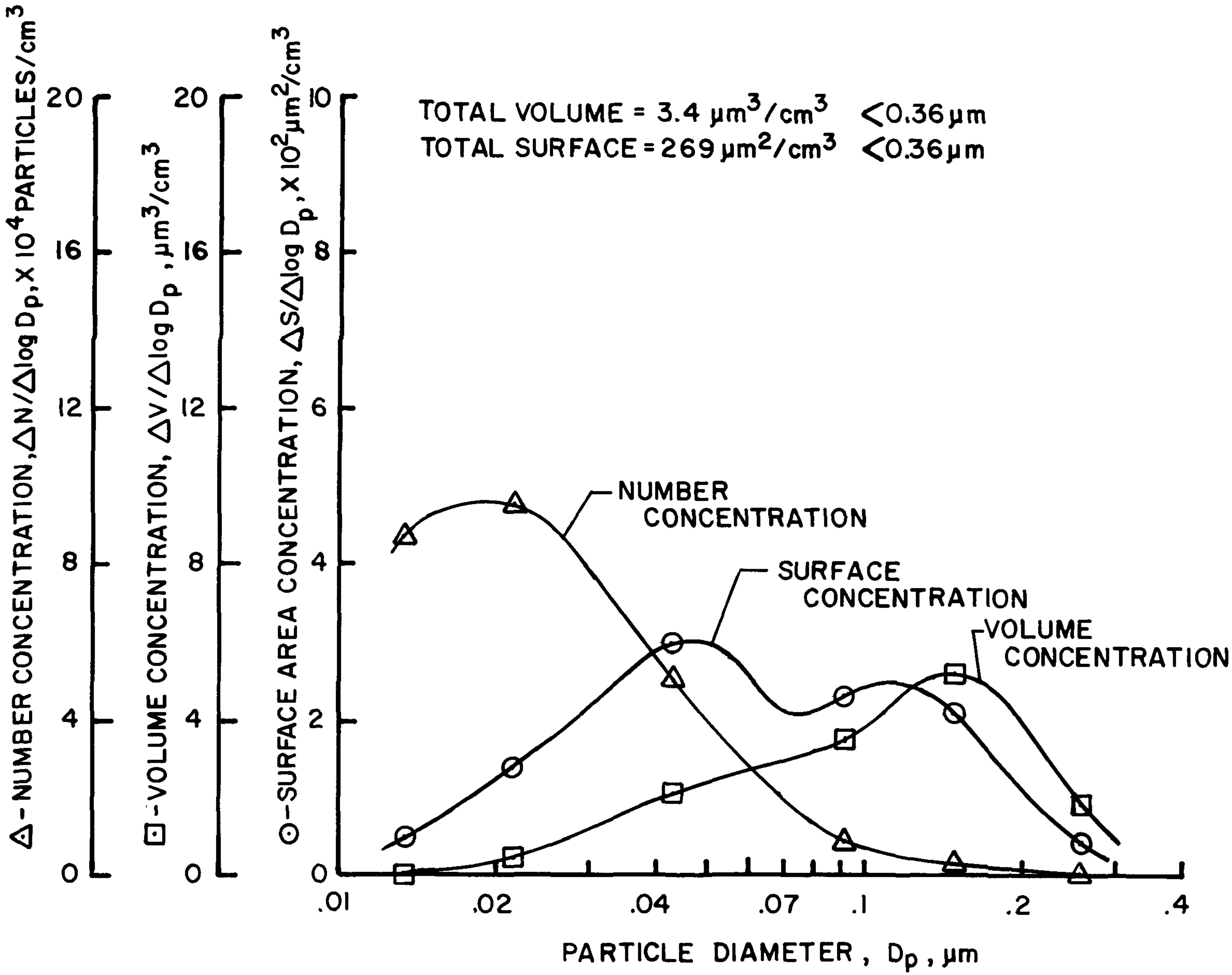

Figure 20. Size distribution of aerosol obtained at 6000 ft msl along sampling route III (see Figure 17). November 15, 1973, 0843 MST.

3. Figure 14 shows that the urban plume could not have been mixed to 7000 ft msl. Therefore, the concentrations encountered east of Henderson in all three traverses could not have been associated with the lower level urban plume.

Although the aircraft was generally above the urban plume during the 6000 ft msl traverse shown in Figure 17, the rising terrain to the west of Henderson was enough of an influence to allow a portion of the urban plume to be sampled between Henderson and Highway 87. The size distribution shown in Figure 20 was taken in the urban plume portion of the 6000 ft msl traverse and the location of the sample is indicated in Figure 17. The distribution shows definite fresh combustion or photochemical aerosol with a surface distribution mode at about 0.05 μm. Approximately 30 percent of the aerosol volume smaller than 0.36 μm is either fresh combustion or photochemical aerosol.

CONCLUSIONS

1. Under the conditions measured, Denver was shown to have a well-developed and well-mixed urban plume which varied in thickness from 500 to 2000 feet depending on the stability and the amount of surface heating. The temperature lapse rate, however, was not always a good indicator of mixing depth.

2. Large buoyant stationary source plumes generate layers aloft which are ventilated to the surface when the mixing layer deepens. These plumes are characterized by high levels of primary pollutants and a deficit of ozone relative to the surrounding air.

3. The chemical and physical characteristics of the urban plume constituents change as the plume ages. In the presence of NO sources, and in the absence of photochemistry, ozone is scavenged; but when sunlight is present, photochemistry is important, and ozone levels in the urban plume can reach or exceed the Federal ambient air standards. Photochemical production of aerosol may also occur in the plume.

4. The aerosol size distribution changes shape as the plume ages, and the submicron aerosol accumulates in the 0.1 to 1 μm diameter size range.

5. The ozone level in clean air outside the urban plume was measured at 0.03 to 0.05 ppm on all flights, while the level in the plume varied from 0.00 to 0.08 ppm depending on the level of photochemical activity and the amount of scavenging by other pollutants.

ACKNOWLEDGEMENTS

This research was funded by the Environmental Protection Agency, and was performed in cooperation with Dr. Jack Durham and Dr. William Wilson of EPA. Some of the instrumentation used on board the aircraft was kindly made available to the project by the California Air Resources Board.

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MEASUREMENTS OF AEROSOL OPTICAL PROPERTIES

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ABSTRACT

Measurement of aerosol optical properties have been made in Denver and at various rural and urban sites in California and Missouri. Measured particle scattering coefficient has been shown to be highly correlated with particle volume in the 0.1 to 1.0 μm range of particle diameter. At times a single ionic substance (NaCl at Pt. Reyes, CA, and $H_2SO_4/(NH_4)HSO_4/(NH_4)_2SO_4$ at Tyson, MO) controlled the aerosol optics as a function of relative humidity.

INTRODUCTION

The aerosol is composed of particles that range in size from smaller than 0.01 μm to larger than 10 μm diameter. The particles are of various chemical compositions and each particle can be a mixture of substances or a single substance. The integral optical effect of the aerosol particles is dependent on all of these parameters. Atmospheric optical properties normally considered would include those of interest from a human impact standpoint, i.e., visibility and colored haze, and those of scientific interest, i.e., scattering and absorption extinction coefficients.

Techniques have been developed at the University of Washington for direct measurement of aerosol optical properties. These measured parameters have been compared to other methods of characterizing the aerosol impact such as visibility or particle mass loading.

ATMOSPHERIC OPTICS AND VISIBILITY

It is convenient to define several parameters commonly used to describe atmospheric optics.

The extinction coefficient b_{ext} of a real atmosphere defines the change in intensity of light traversing a pathlength Δx by the Beer-Lambert law:

$$\frac{\Delta I}{I} = -b_{ext} \Delta x \tag{1}$$

b_{ext} is the sum of two terms:

$$b_{ext} = b_{ext}\text{ (gases)} + b_{ext}\text{ (particles)}$$

$$b_{ext}\text{ (gases)} = b_{Rg} + b_{ag}\text{, where}$$

$b_{Rg}\Delta x$ is the fraction of incident light scattered into all directions by gas molecules in Δx.

$b_{ag}\Delta x$ is the fraction of incident light absorbed by gas molecules in Δx.

Our interest is in b_{ext} (particles) which can be broken down as follows:

$$b_{ext}\text{ (particles)} = b_{ap} + b_{sp} \tag{2}$$

where $b_{ap}\Delta x$ is the fraction of incident light absorbed by particles in Δx.

$b_{sp}\Delta x$ is the fraction of incident light scattered into all directions by particles in Δx.

The observer visibility, or visual range, is that distance at which a black object can be just discerned against the horizon. Koschmieder[1] showed that a turbid media, such as urban air, reduces the contrast (ratio of brightness of an object to the horizon brightness, minus one) of distant objects as given by

$$C = C_o e^{-b_{ext} x} \quad \text{(Middleton}^2\text{)} \tag{3}$$

where C_o and C are the contrast relative to the horizon of an object at zero distance and at distance x. A black object has a C_o of -1. Experiments have determined that typical observers can detect objects on the horizon with a visual contrast of 0.02 to 0.05. Assuming horizontal homogeneity of aerosol properties and illumination and a 0.02 detectable contrast, the visible range is

$$L_v = \frac{3.9}{b_{ext}} \tag{4}$$

For a contrast of 0.05,

$$L_v = \frac{3.0}{b_{ext}} \tag{5}$$

Usually the assumption is made that $b_{ext} = b_{sp}$.

b_{sp} can be calculated from known or assumed aerosol particle size distribution, concentration and refractive index, as discussed below.

PARTICLE OPTICS

The scattering extinction coefficient due to particles, b_{sp}, can be calculated if the particle size distribution, number concentration and refractive index are known and the particles are assumed to be homogeneous spheres. None of the above assumptions are usually true but the results of calculations show useful agreement with atmospheric optical measurements. Figure 1 shows calculated b_{sp} per volume of particle as a function of particle diameter.

The value of b_{sp} is the product of the curve in Figure 1 times the particle volume distribution function. The aerosol particle volume per log radius interval usually is similar to that of Figure 2, bimodal with the two volume modal diameters about 0.6 μm in the 0.1 μm to 1.0 diameter range, as shown in Figure 2. <u>In all the measurements we have made, the particles in the 0.1 to 1.0 decade dominate scattering extinction in the visible spectrum</u> although there clearly are cases in fogs, rain, snow, clouds and dust storms in which large particles influence or dominate visible extinction.

The correlation of b_{sp} measured with an MRI 1550 nephelometer, and 0.1 to 1.0 μm diameter particle volume, measured using an electrostatic mobility and single particle optical counters from Thermo Systems, was 0.95 at various locations in the Los Angeles basin. These measurements, shown in Figure 3, are from the 1973 State of California Air Resources Board ACHEX[3] program.

A correlation of b_{sp} with the supermicrometer volume mode is not expected unless the submicrometer and supermicrometer volume modes happen to be correlated. Thus in this qualitative sense we would not expect to find a particularly good correlation between b_{sp} and measured total mass concentration, for example with the high volume air sampler.

It is somewhat surprising, in view of this, that the measured correlation coefficient between b_{sp} and total aerosol mass concentration is as high as the observed range between 0.5 and 0.9. While the former value is not impressive nor particularly useful, the latter is sufficiently high to allow inference of mass concentration from b_{sp}. Table 1 summarizes the various published correlations of b_{sp} and mass. Included in the table are correlation coefficients, r, and regression constants A and B.

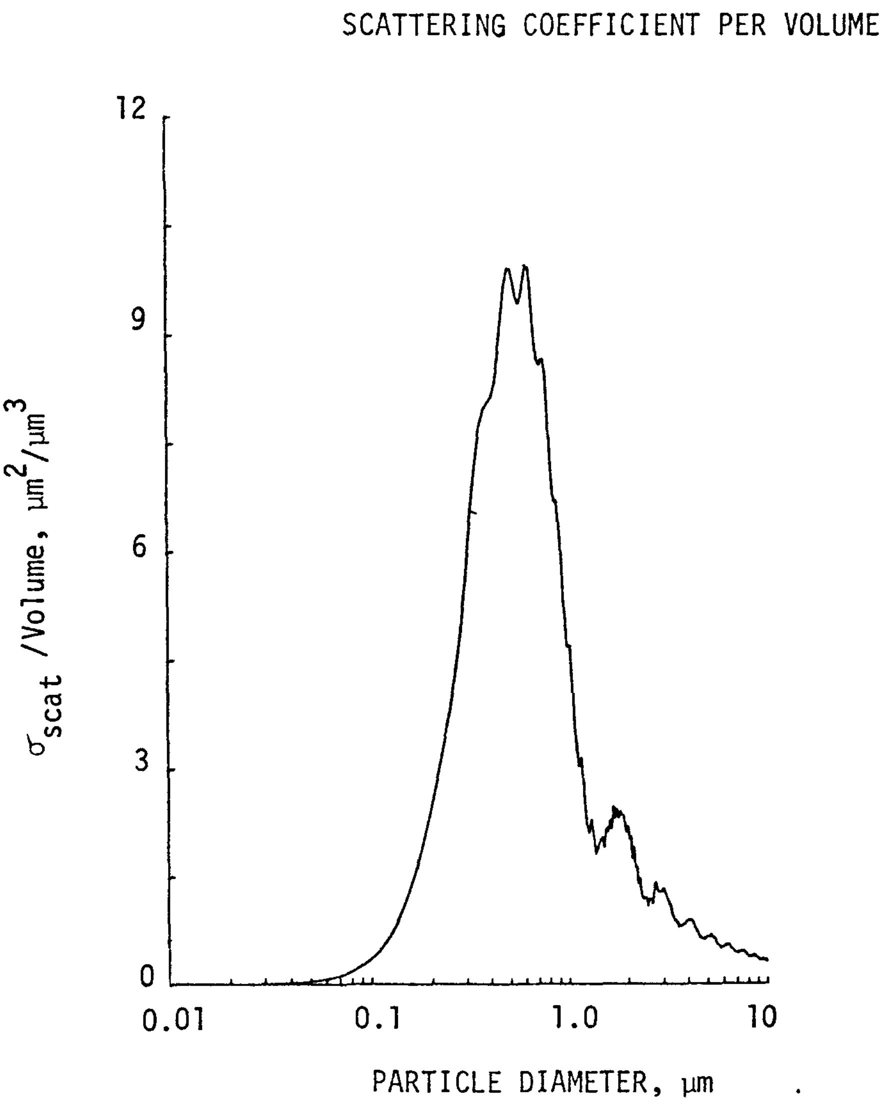

Figure 1. Scattering coefficient per particle divided by particle volume plotted as a function of diameter. The particles are assumed to be spheres of refractive index 1.50 illuminated by 550 nm light.

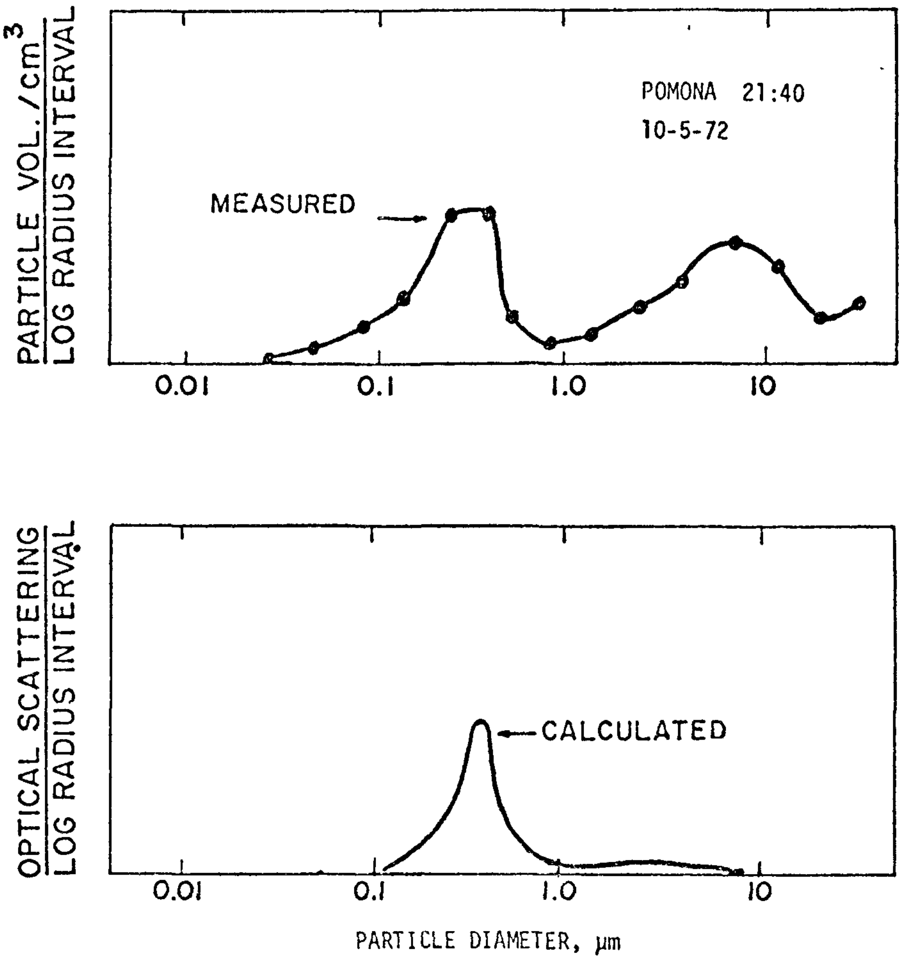

Figure 2. Top: Aerosol particle size distribution measured at Pomona during 1972 State of California Air Resources Board ACHEX program.

Bottom: Calculated optical scattering by particles, b_{sp}, for the measured size distribution. The particles are assumed to be spheres of refractive index 1.5.

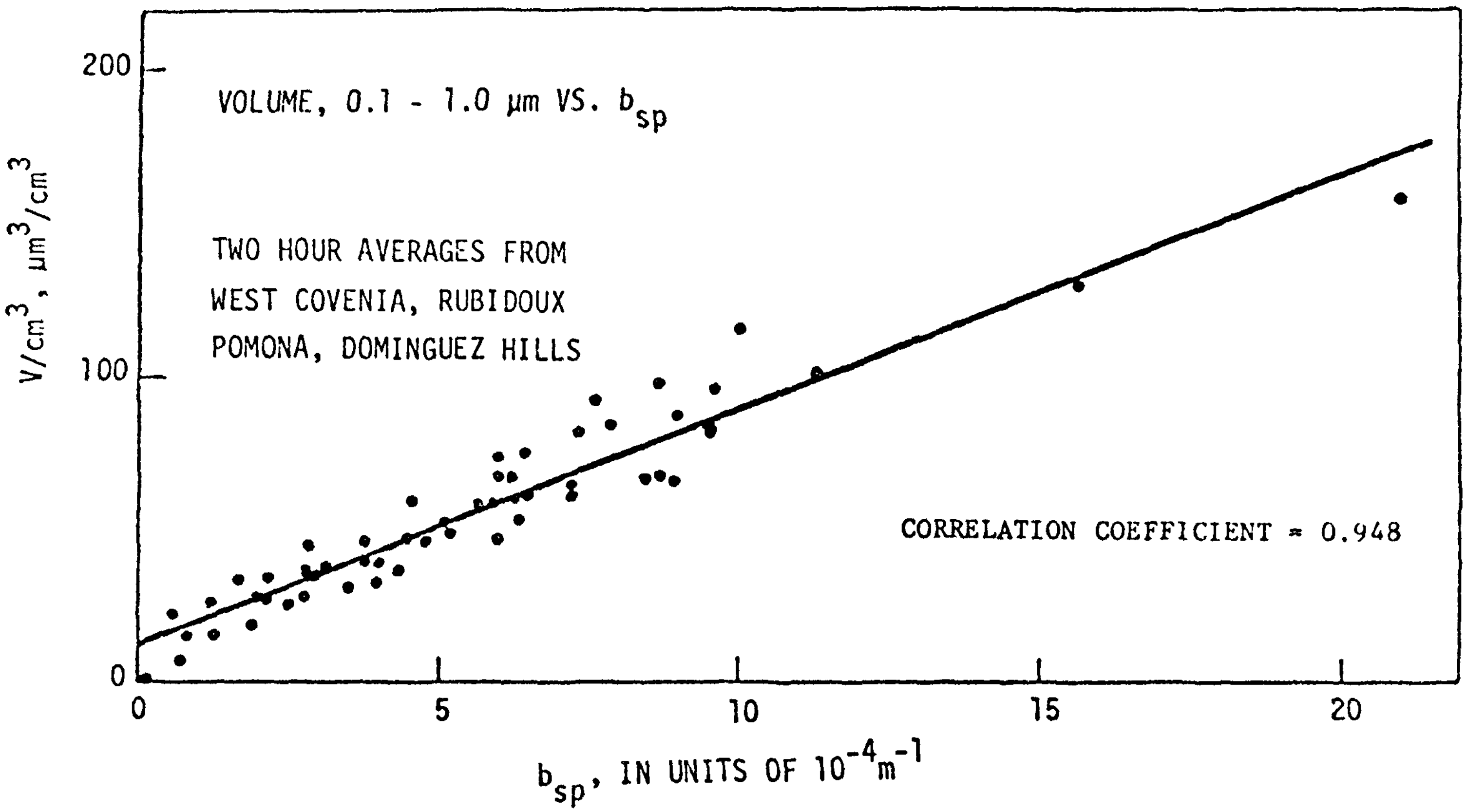

Figure 3. Plot of measured aerosol particle volume including only those of 0.1 to 1.0μm diameter versus measured b_{sp}. Measurements were part of State of California Air Resources Board ACHEX program. Data was supplied by Dr. Clark of North American Rockwell.

TABLE 1. SUMMARY OF LIGHT SCATTERING-FILTERABLE PARTICULATE MASS CONCENTRATION STUDIES

Location (Reference) \ Mass Sampling Method	2.5 cm dia. open face, glass fiber filter			2.5 cm dia. Nuclepore filter			High Volume Air Sample			Glass Fiber filter behind Lippmann-Harris Cyclone		
	r	A	B	r	A	B	r	A	B	r	A	B
Los Angeles (4)	0.83	-0.57	2.4	---	---	---	0.53	-0.09	3.3	0.83	0.33	3.7
Oakland, CA (4)	0.69	-0.40	1.3	---	---	---	0.86	-0.61	2.4	0.79	0.34	3.2
Sacramento, CA (4)	0.95	0.0	2.2	---	---	---	0.93	-0.56	2.8	0.98	0.13	4.4
New York, NY (5)	---	---	---	0.92	-0.33	3.0	---	---	---	---	---	---
San Jose, CA (5)	---	---	---	0.56	1.5	1.7	---	---	---	---	---	---
Seattle, WA (5)	0.83	-0.08	3.5	---	---	---	0.73	-0.26	3.6	---	---	---
Boston, MA (6)	---	---	---	---	---	---	0.86	0.15	2.0	---	---	---

The parameters are: r = linear correlation coefficient;
A and B defined by $b_{sp}(10^{-4}m^{-1}) = A + 10^{-2}B\ (\mu g/m^3)$.

The correlation coefficient of 0.9 in New York City must be due to either a correlation between the upper and lower volume (i.e., mass) modes or an absence of the upper mode. The location at the 16th floor of a Manhattan building suggests the latter since it was well removed from sources of wind blown dust and other mechanically produced particles.

In contrast, the low correlation coefficient in San Jose, CA, of 0.6 was obtained at a dusty athletic field, with the air intake at approximately 7 meters above the ground. In this case, the poor correlation was likely due to a large and variable fraction of the aerosol in the supermicrometer mode.

The wavelength dependence of b_{sp} depends almost exclusively on particle size distribution[7]. The results of measurements to date regarding the wavelength dependence fall into two categories. If the wavelength dependence is described by a simple power law:

$$b_{sp} \propto \lambda^{-\alpha} \qquad (6)$$

where α is an experimentally determined exponent, the two categories are:

1. Normal wavelength dependence where $0.5 \leq \alpha \leq 2$, with a mean value of approximately 1.2.
2. Anomalous wavelength dependence where $-1 \leq \alpha < 0$.

The former case results in the attenuation of blue light from a direct beam and its scattering into 4π steradians around the scattering volume. Of course, Rayleigh scattering always occurs simultaneously and has a wavelength dependence that is similar:

$$b_{Rg} \propto \lambda^{-4} \qquad (7)$$

As a result, blue scattered light (against a dark background) or red transmitted light (from the sun or a bright white object) is no indication by itself of the presence of particles. Whether b_{sp} or b_{Rg} dominates is determined by the amount of particulate matter that is present. In remote, clean marine locations at sea level, Porch et al.[8] showed that $b_{sp} \leq b_{Rg}$ at 500 nm. In continental, low altitude sites, b_{sp} is usually larger than b_{Rg}, so that such hazes can often be assumed to be dominated by b_{sp}. However, clean arctic air intruding or air from aloft subsiding into mid continent cities occasionally produce $b_{sp}<b_{Rg}$. This sort of situation typically arises under post-cold frontal conditions in the midwest and results in unusually high visibility and clear air.

Blue hazes - for example, in mountainous areas - may or may not be due to scattering by particles, depending on viewing conditions (e.g., dark or light background) and the distance from the observer to the background. If the product of b_{Rg} times distance to the background is much above two, the blue haze has a significant input due to b_{Rg}. On the other hand if the product of b_{sp} times distance is of this magnitude, then the haze is likely to be due to particles. Since $b_{Rg,530\ nm} = 0.15 \times 10^{-4} m^{-1}$, if $b_{sp} \sim 0$, mountains should not appear to be behind a haze if they are within 10 km. or so. They will, however, appear hazy if the distance is much more than 100 km. due to the omnipresent scattering by gas molecules. Conversely, if such a distant mountain is not visible at all, $b_{sp} >> b_{Rg}$ and the haze is due to particles.

When viewing bright objects (the sun and moon, sunlit snow-capped peaks and cumulous clouds) hazes with $1 \leq \alpha \leq 2$ of sufficient optical depth cause the color to be reddened[2,9]. The color thus produced is remarkably similar to that observed through an optically thin layer of NO_2[10] so that the presence of color thus viewed is no proof of the existence of NO_2. To further complicate this issue, Husar[11] has shown that light scattered in the backward hemisphere calculated from typical measured size distribution is enriched in the red wavelengths, also causing the haze itself to appear reddened. In forward scatter this same haze appears white. Charlson[12] showed that, in perhaps 20% of the measured cases during August, 1969 in Pasadena, CA, there was enough NO_2 to influence the coloration of white objects viewed through the haze and that in the remaining cases particles dominated the wavelength dependence of total extinction (b_{ext}).

MOLECULAR COMPOSITION

The particle interaction with water, biological effects and complex refractive index depend on the molecular composition. Therefore, it is important that the composition of various aerosol systems be classified, particularly insofar as this determines the imaginary part of the refractive index and hygroscopicity. Unfortunately, this is an area in which so far very little work has been done. Rasmussen[13] suggested that organic materials (terpenes) are a major source of atmospheric particles, but did not quantify the work adequately for application to optics. The reaction products of SO_2 with water and ammonia have been shown to play an important part in urban and rural aerosols by Junge[14] although he did not attempt to relate quantitatively the composition with optical effects. We have preliminary data suggesting that continental aerosol optics is often dominated by H_2SO_4 and the products of its neutralization with NH_3[15,16].

The molecular nature of individual particles is a function of the source and removal mechanisms for these particles. The most important observable effect of composition on particle optics is the relationship of b_{sp} and relative humidity.

RELATIVE HUMIDITY EFFECTS

The humidity effects in aerosol optics fall into three categories:

RH $\leq$ 100%: particles between and above water cloud (including high RH hazes);

RH > 100%: unactivated particles in water clouds and fog;

RH > 100%: activated cloud droplets.

Our efforts have been limited to the first case and are discussed in the following paragraphs.

Since a large fraction of submicrometer particles are hygroscopic or deliquescent[14-18] the size distribution of an atmospheric aerosol and hence its optical or climatological properties, depend largely on relative humidities, even at RH < 50%.

First, light scattering always increases with humidity, although for relatively hygrophobic systems the increase may be very slight up to extremely high RH. While for most aerosols, such as H_2SO_4 droplets the curve increases monotonically, definite inflection points due to deliquescent salts are seen at some locations indicating the dominance by rather pure inorganic substances such as $(NH_4)_2SO_4$ or sea salt (NaCl)[15,16,19].

The evolution of a distribution of droplets under conditions of changing, subsaturation RH modifies the optical interactions between radiation and particles, thus changing the temperature of the environment of the particles and hence in turn the relative humidity. This complex chain of events cannot be satisfactorily modelled until the parameters which go into the models (dependence of particle growth on chemistry, optical properties of saturated and supersaturated droplets, etc.) and the basic physical principles of the component processes are understood.

A system has been designed and operated by this laboratory that (over a period of about 120 seconds) sweeps the relative humidity of air containing aerosol particles from 30% to 95%. Changes in particle diameter are detected as changes in the scattering coefficient of the aerosol particles[15,16,19].

In the midcontinent region 30 km southwest of St. Louis, this system detected $H_2SO_4/(NH_4)HSO_4/(NH_4)_2SO_4$ as dominate materials in the 0.1 to 1 μm decade of aerosol size. Injection of sub ppm concentrations of NH_3 converted the b_{sp}(RH) response characteristic of H_2SO_4 to that of $(NH_4)_2SO_4$. The $(NH_4)_2SO_4$ is detected by comparing the value of relative humidity at the deliquescence point for the unknown sample with that of laboratory-generated $(NH_4)_2SO_4$ aerosol. 98% of the time either H_2SO_4 or $(NH_4)_2SO_4$ was the dominant substance in terms of optical effect[15,16].

TECHNIQUES FOR MEASUREMENTS OF RELEVANT OPTICAL PROPERTIES

In the past several years our efforts have been focused on design and testing of methods to measure aerosol optical properties that directly determine aerosol radiative interactions. Methods for measurement of these relevant integral aerosol optical properties, namely, b_{sp}, b_{bsp}, $b_{sp}(RH)$, and b_{ap}, are described in the following sections.

b_{sp}

Consider a small volume of thickness dx illuminated by a parallel beam of wavelength λ and intensity $I_{o,\lambda}$. For unpolarized light, the intensity of light scattered into solid angle $d\Omega$ at scattering angle Θ is

$$\frac{dI_\lambda}{d\Omega}(\Theta)\,d = I_{o,\lambda}\beta_\lambda(\Theta)\,dx \qquad (8)$$

A visibility meter using the operator's eye as a detector was devised by Buettell and Brewer[20] that geometrically performs the integration of $\beta_\lambda(\Theta)$ over solid angle to measure $b_{sp,\lambda}$[1]. Ahlquist and Charlson[21] increased the original instrument sensitivity by using a photomultiplier tube to detect scattered light from a xenon flash lamp. Ahlquist et al.[22] improved the sensitivity, stability and dynamic range by substituting an incandescent lamp for the xenon flash lamp and detecting the scattered light using digital photon counting techniques. This instrument, called an integrating nephelometer, is shown in Figure 4. Modern versions of Buettell and Brewer's device have sufficient sensitivity to be calibrated in an absolute sense with b_{Rg}, the scattering coefficient of particle-free gases such as He, CO_2, CCl_2F_2.

The geometric errors of the instrument have been studied by Middleton[1], Ensor and Waggoner[23], Heintzenberg and Quenzel[24], and Rabinoff and Herman[25] and are estimated to be 10% or less for the aerosol particle size distributions normally found in the atmosphere.

The modern instrument is alternately filled with ambient and particle-free air and the difference in scattered light intensity is proportional to the scattering extinction coefficient due to aerosol particles, b_{sp}. The measured values of b_{sp} in the atmosphere range from $10^{-7}m^{-1}$ at Mauna Loa Observatory to $3 \times 10^{-3}m^{-1}$ in polluted Los Angeles (0.007 to 150 times the Rayleigh scattering coefficient at 530 nm).

The integrating nephelometer has become an accepted instrument for measurement of aerosol scattering extinction. A series of patents have been issued to the University of Washington based on the designs of the

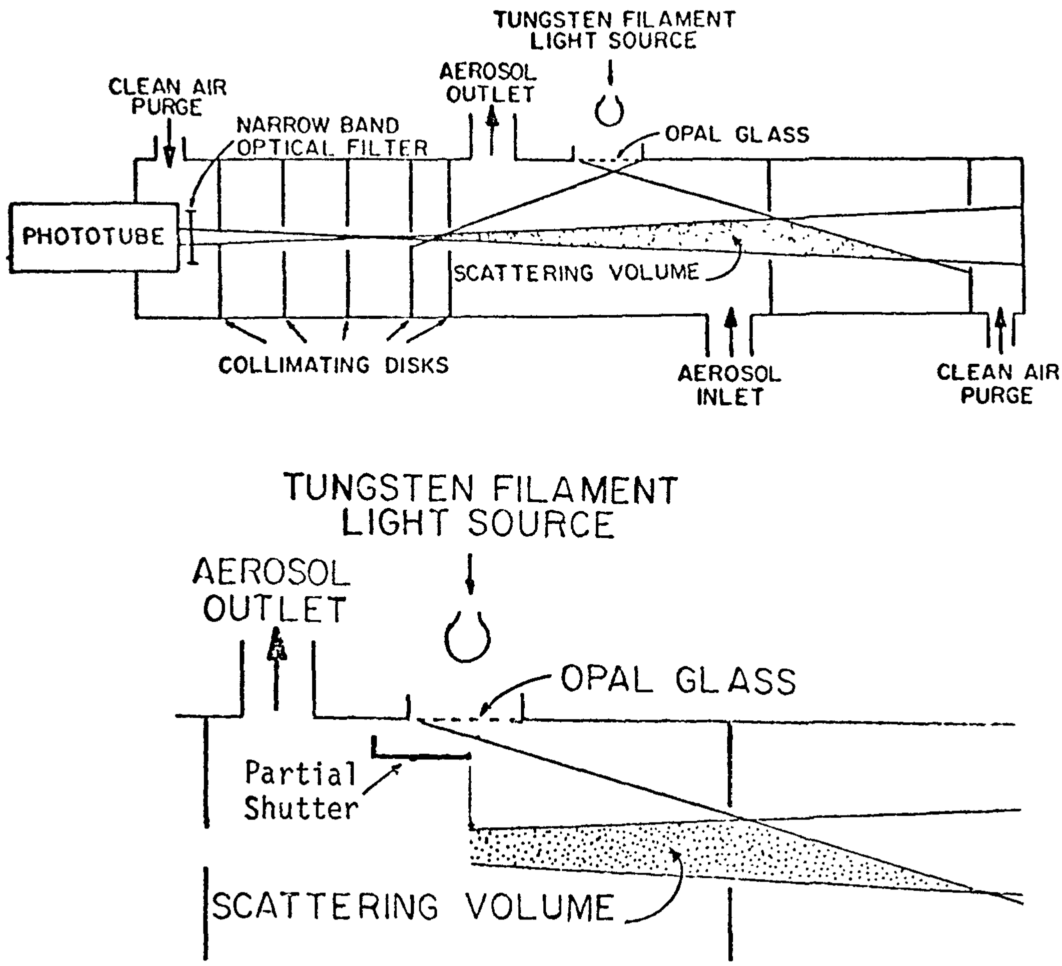

Figure 4. Diagram of nephelometer with enlarged view of the partial shutter. Without the shutter, the instrument integrates the particle scattering coefficient over $\sim 7°$ to $170°$ to measure b_{sp}. With the shutter in place, the instrument integrates over $\sim 90°$ to $170°$ to measure b_{bsp}.

authors of this report covering various aspects of the nephelometer. Several hundred instruments have been produced and are in regular use for both research and monitoring. High sensitivity, multiwavelength instruments have been purchased by Institute für Meteorologie, Mainz, Germany, Air Force Cambridge Research Lab and the National Oceanographic and Atmospheric Administration.

The draft version of Volume I of the ACHEX final report from Rockwell International to the Air Resources Board, State of California, recommends the integrating nephelometer for both long-term monitoring and short-term surveillance of aerosol properties.

$\underline{b_{bsp}}$

An optically thin aerosol layer over a dark surface increases the albedo by scattering incident radiation backwards into space. The albedo per unit thickness of an aerosol layer illuminated by a zenith sun can be determined by integrating the aerosol volume scattering function over the backward hemisphere of scattering angle. A partial shutter, shown in Figure 4, can change the angle of integration of the nephelometer so that the scattered light intensity is proportional to the backward hemisphere scattering extinction coefficient b_{bsp} due to aerosol particles. b_{bsp} normally is in the range 0.1 to 0.2 times the aerosol scattering extinction coefficient b_{sp}.

$\underline{b_{ap}}$

The two aerosol parameters needed in simple radiative climatic models are the particle backward hemisphere scattering coefficient, b_{bsp}, and the particle absorption extinction coefficient, b_{ap}. There are a number of ways of measuring b_{ap}, and none is entirely satisfactory.

Long path extinction cannot be used because b_{ap} is $10^{-4}m^{-1}$ to $10^{-8}m^{-1}$ or smaller. Various techniques based on inverting angular scattering information have been used by Eiden[26] and Grames et al.[27], etc., but these methods require precise knowledge of the aerosol size distribution, and contain errors of unknown size and magnitude, since the scattering by irregular particles is calculated using Mie formulae for spheres. The absorption coefficient of collected aerosol samples can be estimated with low precision from measurement of the transmission of KBr pellets containing dispersed aerosol[28]. Lindberg and Laude[29] measured aerosol absorption by measuring the decrease of diffuse reflectance of a white powder when a small amount of aerosol is dispersed in it.

All of the above methods, in our opinion, are poorly suited for measurements in background locations. Measurement of the angular dependence of the aerosol volume scattering function is difficult when molecular scattering dominates. The methods of Volz and Lindberg require collecting an aerosol sample over several days, scraping the sample off the collecting surface and dispersing the sample in another media. Any treatment of the sample that alters the aerosol size distribution will alter the optical absorption coefficient[30,31]. A different technique for measurement of b_{ap} has been developed in our laboratory that we believe is superior to those described above.

Atmospheric aerosol is collected by passing ambient air through a Nuclepore filter. The filter consists of a 10 μm thick film of polycarbonate plastic with 0.4 μm holes etched through it. The holes are etched along damage tracks from highly ionizing particles and are round and perpendicular to the surface of the film. Individual particles with a mean separation of several diameters are collected on the surface of the filter. The filter and the particles are placed in an optical system that illuminates the particles and the filter with a parallel beam of, in this case, green light and collects both direct transmitted and forward scattered light. The extinction or change in transmission between a clean filter and the filter plus aerosol is assumed to be the same as absorption by the same aerosol dispersed in a long column of air. Knowing the volume of air passed through the filter during collection of the aerosol, one can calculate the optical absorption coefficient due to particles, b_{ap}.

This method has been checked for accuracy using laboratory aerosols of known (including zero) absorption coefficient and is described by Lin et al.[32]. The disadvantages of the method center on errors introduced by sample alteration that may take place during collection, but the sample alteration is probably much less than in the techniques of Volz and Lindberg. The sample collection is simple and only requires 10 to 20 μg/cm² of aerosol on the filter.

ATMOSPHERIC MEASUREMENTS AND DATA

b_{sp} and Visibility

As discussed in Section II, Koschmieder[1] related b_{ext} to the distance at which a black object is just visible when viewed against the horizon sky. The distance of visibility is given by

$$L_V = \frac{3.9}{b_{ext}} \qquad \text{(Middleton}^2\text{)} \qquad (4)$$

assuming aerosol homogeneity, uniform illumination and a 0.02 detectable contrast. Commonly it is assumed that $b_{ext} = b_{scat}$, i.e., $b_{abs} = 0$. Measurements of b_{scat} and observer visibility show good agreement with the formula above.

Horwath and Noll[33] conducted a study in Seattle between total light scattering, b_{scat} measured with an integrating nephelometer, and prevailing visibility observed by two separate people. Their results were in good agreement with the theoretical expression of Koschmieder when only data for RH < 65% RH were included. Apparently the location of the nephelometer in a heated room caused reduced RH in the light scattering measurements. In the cases where RH < 65%, the correlation between b_{scat} and prevailing visibility was 0.89 and 0.91, respectively with a coefficient in the Koschmieder expression of 3.5 ± 0.36 and 3.2 ± 0.25, respectively. This can be compared with the theoretical value of 3.9, indicating a slightly lower prevailing visibility than meteorological range. Since no ideal black targets were used (only trees, buildings, etc.), these would have caused just such a deviation.

Samuels et al.[4] conducted the most extensive tests to date of the relationship of prevailing visibility to light scattering and various mass concentration measures as discussed earlier.

They conclude that b_{sp} as measured with the integrating nephelometer is a good predictor of prevailing visibility and that the regression analysis is in agreement with Koschmieder's theory. These workers noted that there was a smaller observed prevailing visibility than that predicted from theory and b_{sp} measurement, which they suggested was due to non-ideal black visibility targets.

MEASUREMENTS OF SCATTERING PARAMETERS

Under support from the Environmental Protection Agency, National Science Foundation, and the California Air Resources Board, we have measured various aerosol scattering parameters in urban and rural locations in California, Colorado and Missouri. In all locations the incoming air was heated 5° to 20°C above ambient to lower relative humidity of the sample. The measured parameters were:

$\underline{b_{sp}}$ - Scattering extinction coefficient of particles at 530 nm. (Rayleigh at 530 nm = $0.15 \times 10^{-4} m^{-1}$)

$\underline{\alpha}$ - Wavelength dependence of b_{sp} parameterized as

$$b_{sp} = K\lambda^{-\alpha} \qquad (10)$$

Two values of α were computed from Red-Green b_{sp} and Blue-Green b_{sp}. Red is 640 nm. Blue is 430 nm. Green is 530 nm.

Scat. ratio - Ratio of half sphere back scatter to b_{sp} from particles at 530 nm.

The sites were:

Richmond - Northeast corner of San Francisco Bay in vicinity of petro chemical plants.

Point Reyes - Coast Guard station on cliff 150 meters above the sea surface, 50 km NW of San Francisco.

Fresno - Central valley of California, urban agricultural site.

Hunter Liggett - Rural California site 20 km inland from ocean. Local elevation 400 m. Local vegetation consisted of dry grass and sparce trees.

Cal. Tec. - Site on campus in Pasadena in Los Angeles basin.

Pomona - Site at county fairgrounds in inland area of Los Angeles basin.

Washington Univ. - Campus site located in residential area of St. Louis, MO.

Tyson - Rural area 25 km WSW of St. Louis.

St. Louis Univ. - Campus site in industrial St. Louis.

Henderson - Site 10 km NE of Denver.

Trout Farm - Site 8 km N of Denver.

Table 2 lists the measured values at each site. For each measurement parameter, the range of that parameter containing 63% of the data is specified. For b_{sp}, the units are $10^{-4}m^{-1}$ and the range low to high contains 63% of data.

b_{ap} Measurements

Using the technique described in section VI, C, measurements were made of b_{ap} at two locations NE of Denver and three sites near St. Louis during Fall of 1973. The measured values of the ratio of absorption to extinction are presented in Figure 5. In Denver, the absorption to extinction ratio is very high, indicating that the aerosol heats and stabilizes the lower atmosphere. At the three Missouri sites the measured values are as one would expect - the rural area (Tyson) has a less absorbing aerosol than the industrial site (St. Louis University). Only the industrial MO site had absorption comparable to that measured outside Denver.

The probable chemical species that produces the absorption is graphitic carbon. Without chemical analysis for this material it is only possible to speculate about the nature of Denver's very absorbing aerosol. The absorption could result from:

(1) high graphitic carbon content.
(2) large concentrations of graphitic carbon particles smaller than 0.1 μm.

TABLE 2. LISTING OF MEAN AND VARIATION INCLUDING 63% OF MEASUREMENTS FOR FOUR SCATTERING PARAMETERS IN 11 LOCATIONS

Location	b_{sp} (530nm)	b_{sp} low	b_{sp} high	αRG	αBG	Scat. Ratio	Start	End
	(Units	of 10^{-4}	M^{-1})				Mo./Day/Hr.Yr.	
Richmond	0.4	0.2	1.4	0.8±0.9	1.2±1	- - - - - -	8/7/17/72	8/12/15/72
Point Reyes	0.12	0.04	0.4	0.25±1.0	- - -	- - - - - -	8/15/11/72	8/25/6/72
Fresno	1.0	0.3	1.9	1.0±0.4	1.7±0.5	18±5%	8/29/9/72	9/8/14/72
Hunter Liggett	0.4	0.2	0.8	1.4±0.8	1.6±0.6	- - - - - -	9/12/9/72	9/15/10/72
Cal. Tec.	1.5	0.8	3.0	1.5±0.4	1.5±0.3	20±8%	9/20/10/72	10/2/8/72
Pomona	1.8	0.6	6.0	1.3±0.4	1.3±0.7	16±8%	10/4/11/72	10/31/15/72
Wash. Univ.	1.58	1.12	2.24	1.47±0.4	1.00±0.4	11±1%	8/25/2/73	8/31/9/73
Tyson	0.63	0.28	1.41	1.80±0.4	1.25±0.5	14±4%	9/3/19/73	9/27/12/73
St. Louis Univ.	0.71	0.40	1.25	1.85±0.3	1.25±0.3	14±2%	9/27/20/73	10/4/15/73
Henderson	0.31	0.08	1.25	1.65±0.8	1.15±0.6	17±8%	11/10/--/73	11/14/--/73
Trout Farm	0.56	0.22	1.58	1.75±0.7	1.30±0.5	18±6%	11/15/10/73	11/23/11/73

The parameters and sites are discussed in the text. Note that in all locations the sample air was heated 5^{o} to 20^{o} above ambient temperature.

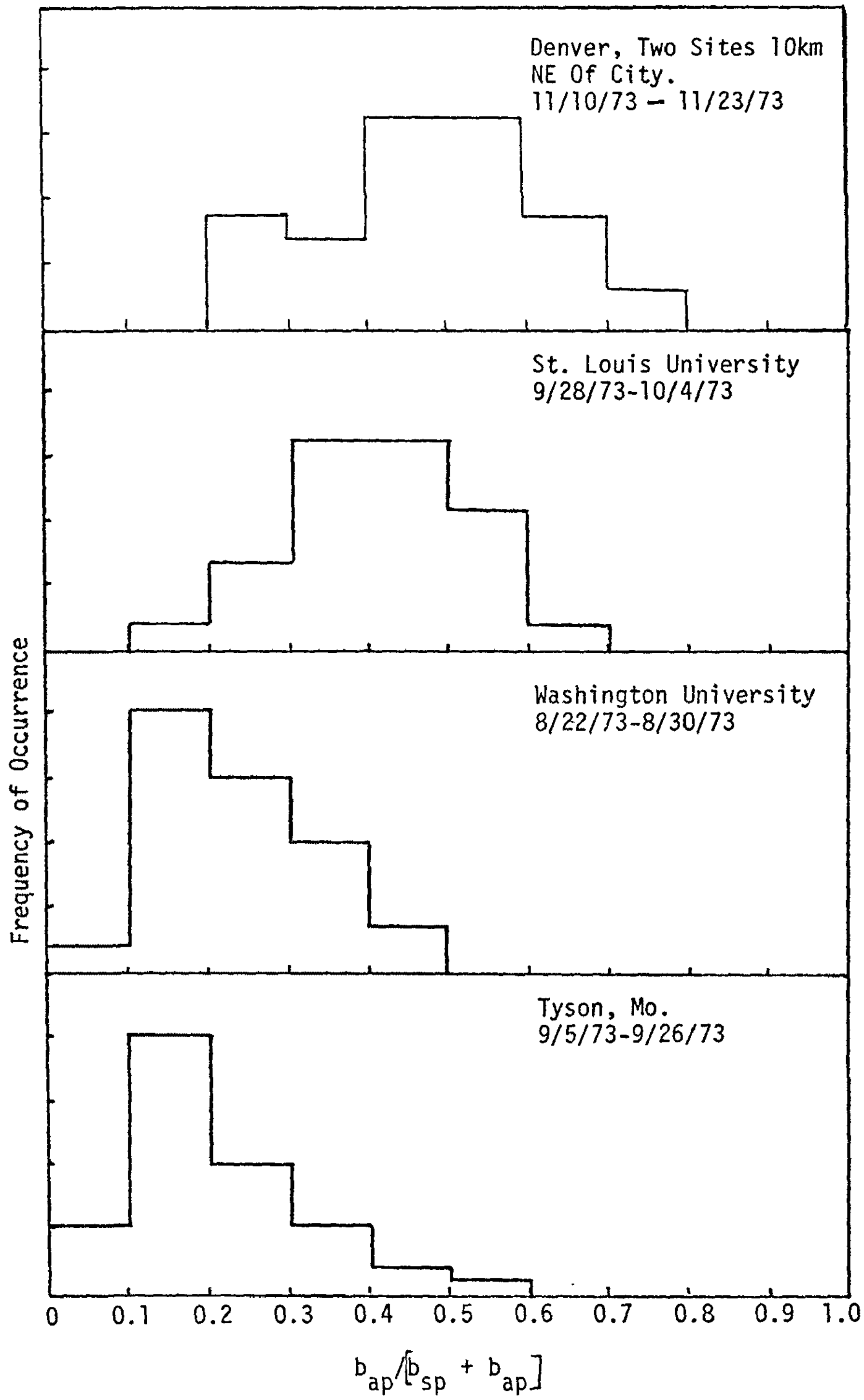

Figure 5. Ratio of absorption to extinction by particles. Data shown is from Fairground and Trout Farm sites NE of Denver and three sites near St Louis, Mo.

(3) lack of $(NH_4)_2SO_4$ as a major component of Denver aerosol when compared to that found in rural Missouri.

The ratio of absorption to filterable particulate mass can be used to estimate an imaginary refractive index for the aerosol if a size distribution and chemical uniformity are assumed. We believe the particles are not uniform chemically and prefer to report b_{sp} rather than n_2. With this warning, the average aerosol b_{ap} at Denver was 0.35 x $10^{-4}m^{-1}$. The imaginary refractive index, n_2, given the stated assumptions was 0.035.

CONCLUSIONS

Comparisons can be made between our measurements at Denver and other locations. Deliquescent salts were not detected in the aerosol at Denver and the b_{sp}(RH) curves were at times quite hygrophobic. The aerosol is less water soluble in Denver than at other sites.

The aerosol had somewhat higher backscatter to b_{sp} ratio and much higher b_{ap}/b_{ext} than values of the same parameter at other locations. Both measurements could be explained by a shift of the small particle mode to smaller particles. The absorbing character of Denver aerosol may enhance the brown or yellow color of distant white objects viewed through the urban plume.

ACKNOWLEDGEMENTS

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CHARACTERIZATION OF DENVER AIR QUALITY

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ABSTRACT

The GM Atmospheric Research Laboratory (ARL) monitored ambient air quality at the General Motors Vehicle Emission Laboratory in Denver from November 4 through December 14, 1973. The site was about 6 km north of downtown Denver in the industrialized South Platte River Valley --an area that lies in the trajectory of the urban plume and the "Brown Cloud."

Average concentrations of SO_2 and CO measured during the investigation were low, (as compared to federal standards), at 0.006 and 2.3 ppm, respectively, while the NO_2 average was relatively high at 0.07 ppm. There were several severe pollution episodes where concentrations rose well above these average values. These episodes were the result of long-lasting, low-level inversions which trapped Denver's urban and industrial plumes in the South Platte River Valley northeast of the city. The resulting brown haze had a variable composition--as indicated by the relative amounts of individual hydrocarbons--ranging from rich in auto exhaust to poor in auto exhaust and high in pollutants from stationary sources.

INTRODUCTION

Due to its particular topography and meteorology, Denver has unique air pollution problems which are only partially understood. During late fall, the Denver metropolitan area is subjected to frequent atmospheric inversions which prevent dispersion of airborne pollutants, forming a haze over the north end of the city.[1] This visual phenomenon, known locally as the Brown Cloud, has been the subject of several recent studies attempting to determine its composition and cause. In 1971, EPA (and others) conducted a preliminary investigation to identify the sources of Denver aerosol. This proved inconclusive, and a second study was planned.

The ARL went to Denver in November, 1973 to study the chemical composition of the gaseous pollution. Sampling was conducted near the center of the polluted industrial area in a site immediately removed from any large source. November, the month with the most severe air pollution, was also chosen by EPA and the Denver Research Institute for the Denver Air Pollution Characterization Study, a larger and more comprehensive program than the study conducted in 1971.

FIELD SAMPLING

The ARL was parked in the lot behind the GM Vehicle Emission Laboratory in Denver, about 6 km northeast of the downtown area. Figure 1 is a map of the area. The closest building was 15 m east of the ARL and only about 8 m high. There were no buildings over 10 m high within 0.5 km. The north side of Denver, chosen because of the prevailing SSW winds, is heavily industrial. Within 3 km of the ARL were located: 3 freeways, a power plant, oil refineries, and a sewage disposal plant. Nearly all of the major pollutant sources lie in the South Platte River Valley, about 22 km from the foothills of the Rocky Mountains.

The sampling period, November 4 through December 14, corresponds with the season of Denver's most severe air pollution episodes. November is the month with the lowest average dispersion index and highest percentage of low-level inversions. Consequently, it is also the season with the highest concentrations of particulates and other pollutants.[1] The first several weeks of the period were chosen by EPA and local authorities for the Denver Air Pollution Characterization Study (DAPCS), with which we cooperated.

Tables 1 and 2 list the variables measured in Denver and indicate the methods used. A general description of the instruments and procedures used on the ARL can be found elsewhere.[2]

RESULTS

The continuous monitors were scanned once every minute and the voltages recorded on magnetic tape.[2] Voltages were averaged over five-minute periods and then calibrated. Wind direction and speed were averaged vectorially. Hourly averages, derived from the calibrated five-minute points, are presented in Appendix A. To be listed, an hourly value was required to include at least six five-minute averages. Table 3 lists a summary of these data. Figures 2, 3, and 4 are log-normal plots showing the frequency distributions of various pollutants for the six-week sampling period.

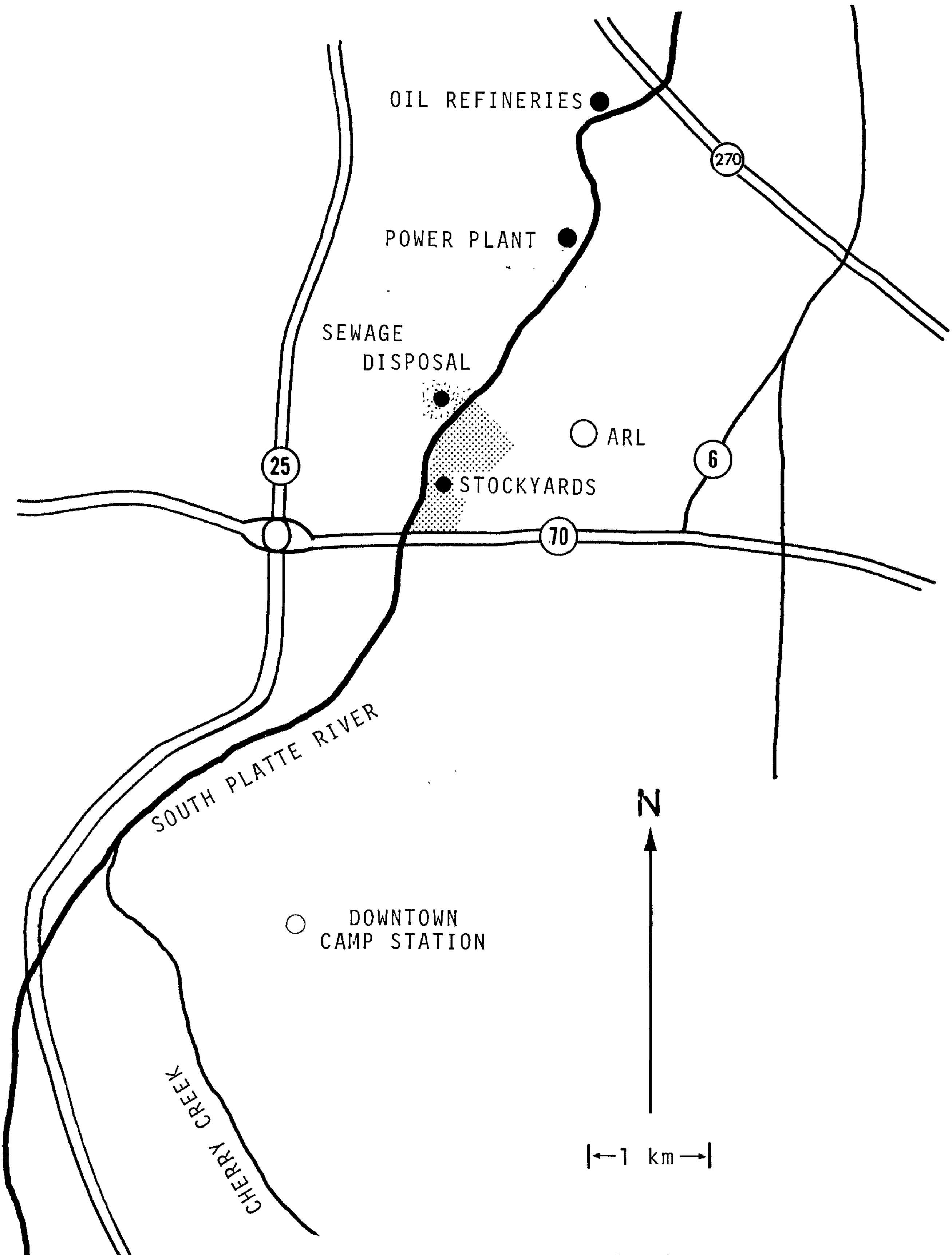

Figure 1. Map of Denver, Colorado.

TABLE 1. CONTINUOUS DATA

Parameter	Method
Wind Direction (Vector)	Derived from 1-min. points averaged vectorially
Wind Speed (Vector	Derived from 1-min. points averaged vectorially
Wind Speed (Scalar)	Scalar average of speed
Wind Sigma	Analog computer
Temperature	Pt resistance thermometer
Dew Point	Dew Cell
Ultraviolet	Radiometer
Rain	Bucket
Ozone	Chemiluminescent
Oxidant	Mast
NO_2	Saltzman
NO_2	Chemiluminescent
NO	Chemiluminescent
NO_x	Chemiluminescent
Visibility (b_{scat})	Integrating nephelometer
THC	Flame ionization detector (FID)
CH_4	FID gas chromatograph
CO	FID gas chromatograph
CO	Nondispersive infrared
THC	FID
SO_2	Flame photometric
Temperature	
Humidity	Monitored inside the ARL
Barometric Pressure	

TABLE 2. HOURLY CHROMATOGRAPHIC DATA

Ethane	2,2,3-Trimethylbutane
Ethylene	Cyclohexane
Acetylene	Benzene
Propane	2-Methylhexane
Propylene	3-Methylhexane
Freon 12	1-Heptene
Isobutane	n-Heptane
n-Butane	Methylcyclohexane
1-Butene	2,2,3- and 2,3,3-Trimethylpentane
Freon 22	1,3,4-Trimethylpentane
Isobutylene	Toluene
2-Butene	1-Methylcyclohexene
1,3-Butadiene	2,2,5-Trimethylhexane
Isopentane	n-Octane
1-Pentene	Ethylbenzene
n-Pentane	m- and p-Xylene
2-Pentene	o-Xylene
2-Methylbutane	n-Nonane
2,2-Dimethylbutane	n-Propylbenzene
2-Methyl-1-Pentene	sec-Butylbenzene
Cyclopentane	n-Decane
2-Methylpentane	n-Undecane
3-Methylpentane	n-Dodecane
1-Hexene	
n-Hexane	
2-Hexene	

TABLE 3. STATISTICAL SUMMARY OF HOURLY AVERAGE DATA

Variable	Units	No. of Hours Average	Average	Minimum	Maximum
Wind speed	m/s	854	2.5	0.3	11.9
Temperature	°C	854	3	-11	21
Dew Point	°C	854	-7	-17	6
Relative humidity	percent	854	50	13	100
Ultraviolet	mJ/cm^2-s	854	0.26	0.00	1.67
CO*	ppm	586	2.3	0.0	16.4
Total HC*	ppmC	586	3.7	1.9	12.4
CH_4	ppm	586	1.7	0.8	10.4
Non-CH_4 HC*	ppmC	586	2.0	0.0	8.2
NO	ppm	780	0.14	0.00	1.27
NO_2**	ppm	780	0.07	0.00	0.47
NO_x	ppm	780	0.22	0.00	1.48
SO_2	ppm	687	0.006	0.000	0.066
O_3	ppm	624	0.01	0.00	0.09
Oxidant***	ppm	850	0.01	0.00	0.12
Aerosol b_{scat}+	10^{-4} m^{-1}	823	1.5	0.14	11.24

*measured using a gas chromatograph with FID
**measured using chemiluminescence by difference (NO_x - NO)
***uncorrected for NO_x interference
+local visual distance, km = $47/b_{scat}$

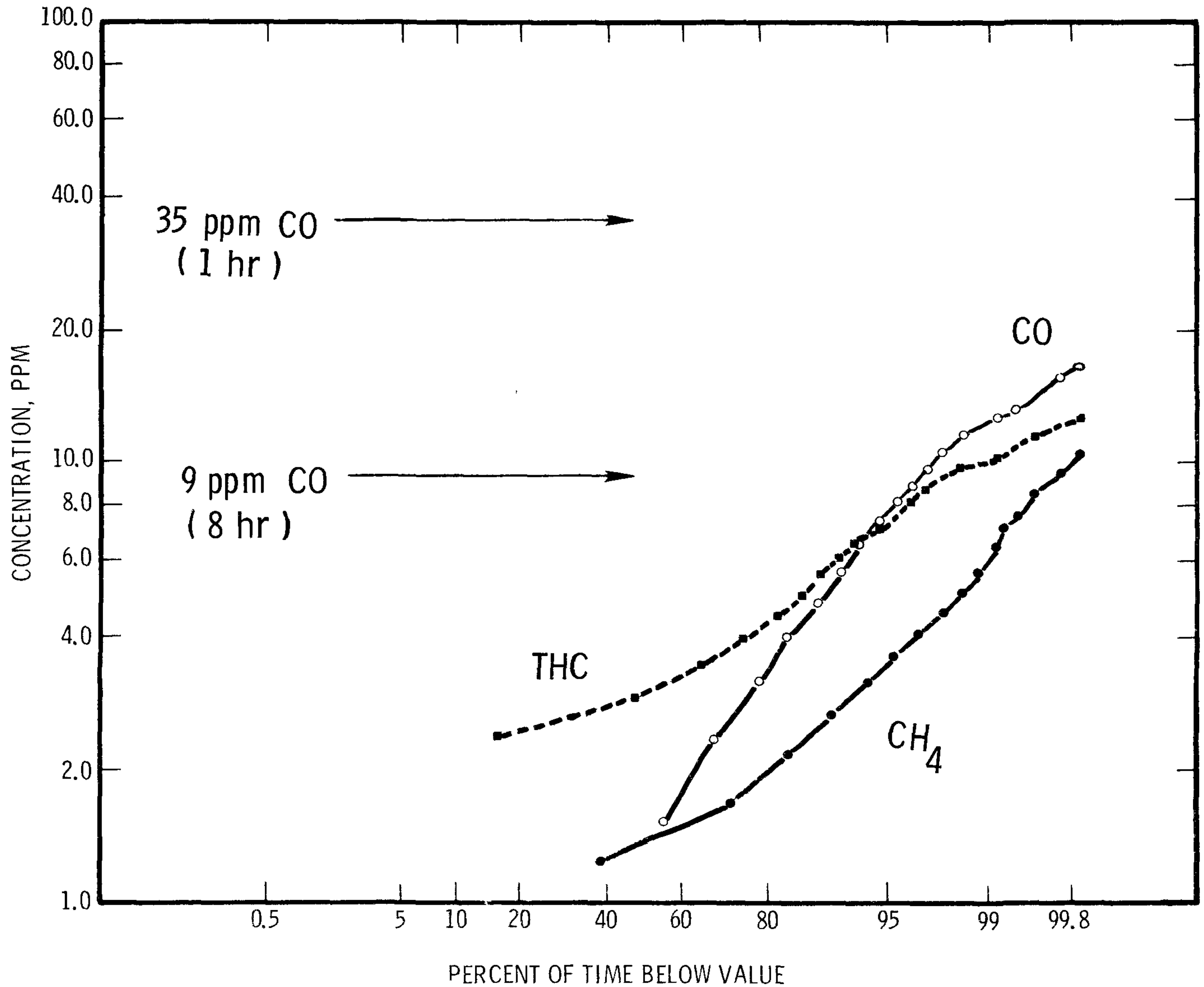

Figure 2. Log-Normal Frequency Distributions of CO, THC, and CH_4.

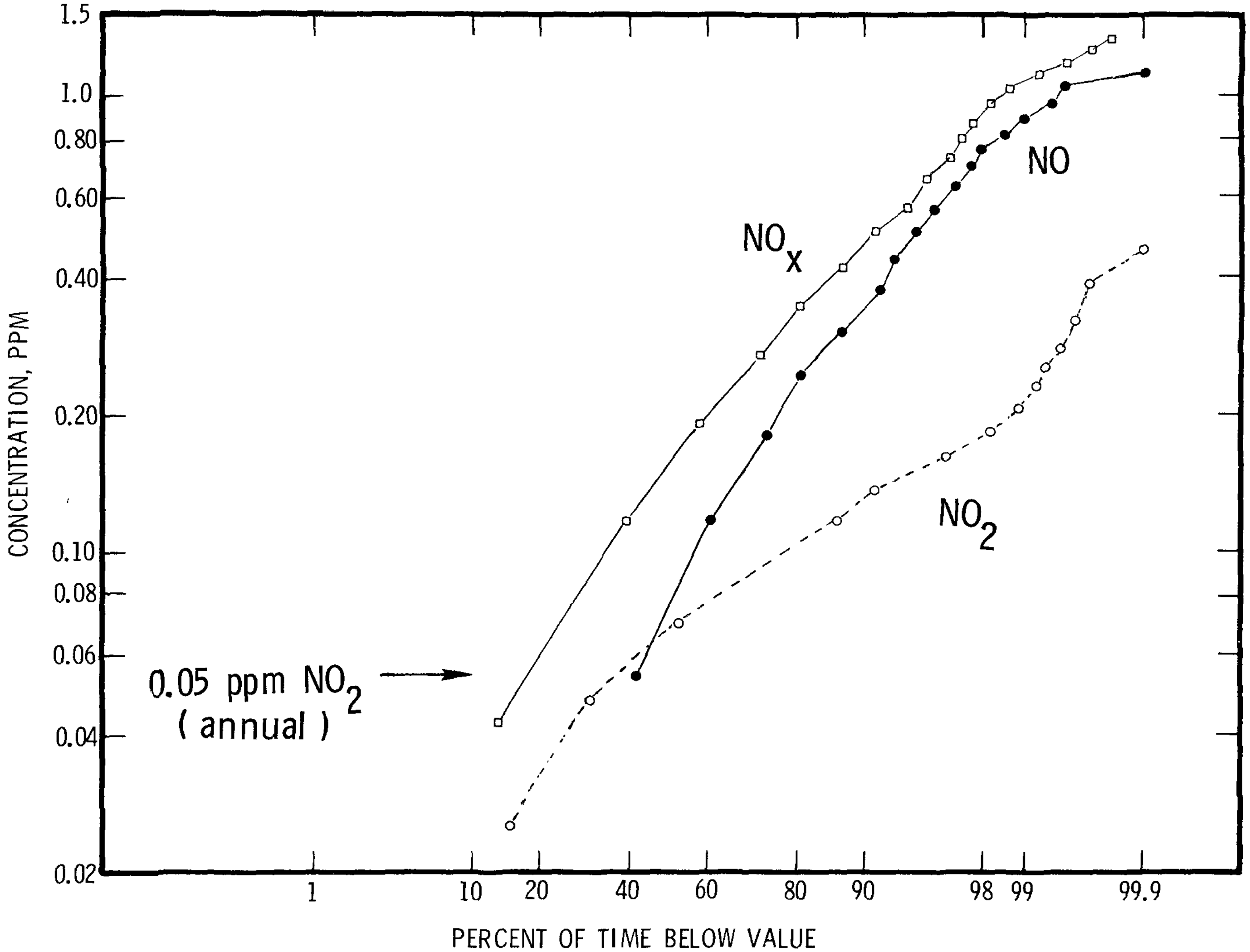

Figure 3. Log-Normal Frequency Distributions of NO_x, NO, and NO_2.

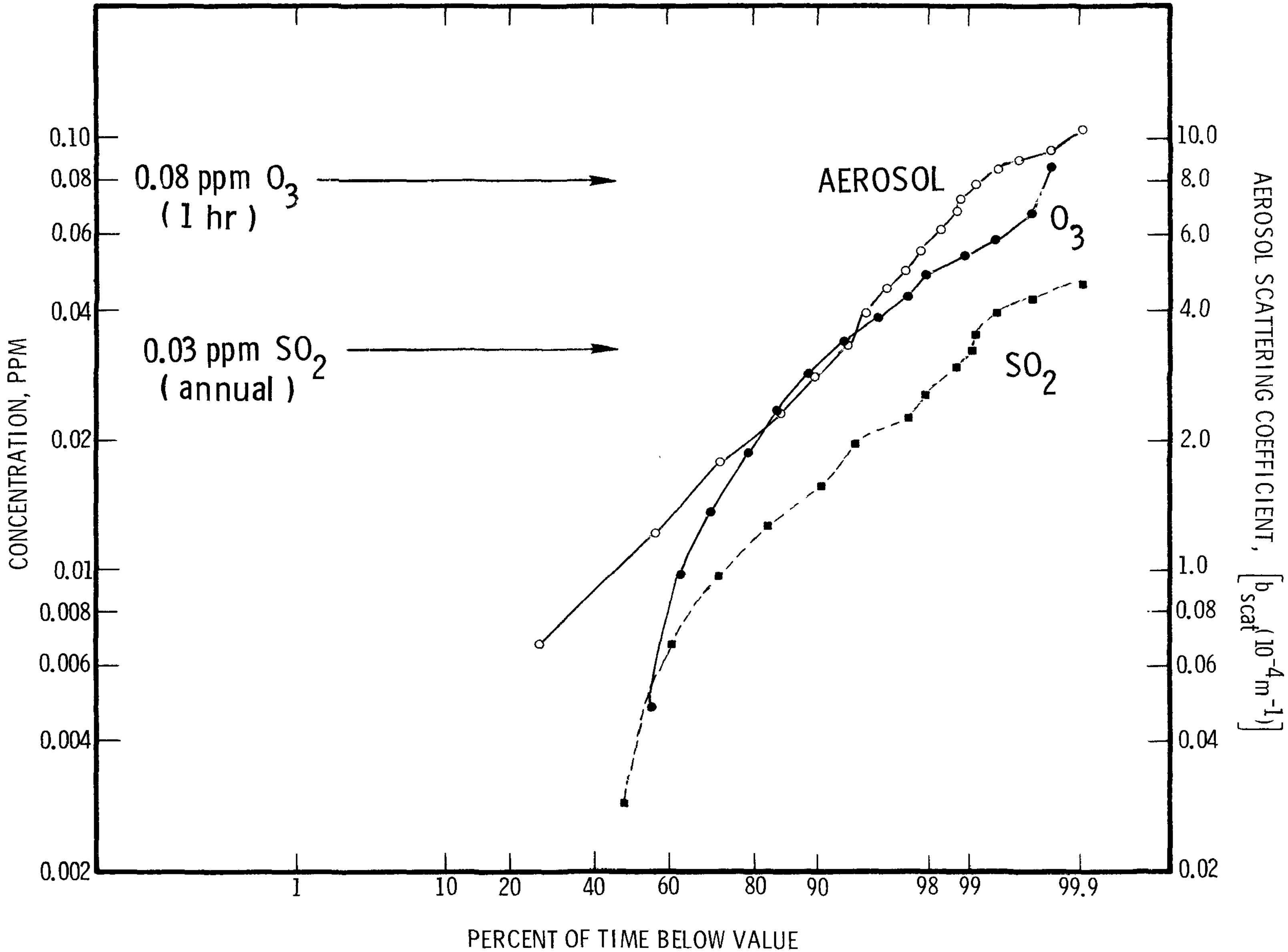

Figure 4. Log-Normal Frequency Distributions of O_3, Aerosol, and SO_2.

The individual hydrocarbon data from the gas chromatograph are presented in Appendix B. Under normal operating conditions, one run was made every hour. The values listed are based on the response of a flame ionization detector which is linear with concentration for any particular hydrocarbon at ambient levels. The response to different compounds, however, may deviate slightly from the linear multiple of carbon atoms. An average response factor based on "peak area" has been used here. A statistical summary of the most common hydrocarbons is presented in Table 4.

DISCUSSION OF RESULTS

Meteorology

During the sampling period, several fronts passed through Denver, creating a variety of weather conditions typical of the season. There was very little rain and some snow. Temperatures ranged from -11° C to 21° C, relative humidity from 12% to near 100%. Average temperature and humidity were 3.3° C and 50%, respectively. The maximum hourly ultraviolet dosage was 6 J/cm^2, and the average daily dosage was 23 J/cm^2. As expected, these values are considerably lower than 10 J/cm^2 and 40 J/cm^2--the maximum hourly and average daily UV dosage measured in the Los Angeles Basin[3] during September and August of the same year (due to Denver's lattitude, greater cloud cover, and the later time-period).

Winds were moderate, averaging 2.5 m/s. Half of the time the speed was below 2 m/s and 90 percent of the time it was less than 5 m/s. Prevailing wind patterns were remarkably consistent over the sampling period, comparing well with historical data.[1,4] Figure 5 shows the average diurnal variation of wind speed and three roses depicting the distributions of directions (based on the five-minute vector wind directions). Typically, winds were low (1.5 - 2.5 m/s) and from the SSW in the morning, while afternoon winds increased to over 3 m/s and blew from the NNE (or NW during unstable periods). By 2000, winds again were low and out of the SSW. The ARL data compares well with the data reported for the same period by Crow for the DAPCS.[5] Pollution episodes are characterized by early morning inversions which often burn off around 1100; this occurs about three-fourths of the time during this season. On the few days of severe episodes, the inversion may not be broken all day. Above the mixed layer are various inversion layers where there is no verticle mixing.[5] These result in polluted layers at heights of from 100 m to 500 m.

Comparison with Standards

Any sampling period lasting only six weeks cannot be considered representative of all a city's pollution problems. For example, ozone is mostly a problem during the summer, and the Federal standard of 0.08 ppm was barely exceeded on two afternoons at the ARL. (A recently published EPA report states that for 1972 this standard was exceeded on

Table 4. Statistical Summary of Hydrocarbon Data*

Hydrocarbon --	Average	99th Percentile	Maximum
	(ppbC)		
Ethane	69	447	638
Ethylene	53	304	508
Acetylene	59	344	530
Propane	95	785	924
Propylene	25	146	243
Isobutane	58	557	857
n-Butane	123	685	979
Isopentane	111	600	999
n-Pentane	68	586	781
2-Methylpentane	53	424	652
3-Methylpentane	37	254	509
n-Hexane	55	321	535
2,2,3-Trimethylbutane	32	218	485
Cyclohexane	17	164	547
Benzene	18	116	178
2-Methylhexane	34	198	441
3-Methylhexane	38	240	481
1-Heptene	20	135	301
n-Heptane	33	210	420
Methylcyclohexane	28	177	272
Toluene	64	338	520
1-Methylcyclohexane	23	120	239
n-Octane	22	153	766
Ethylbenzene	15	80	115
m- and p-Xylene	47	260	372
o-Xylene	24	142	571
n-Nonane	19	116	334
sec-Butylbenzene	30	167	419
n-Decane	22	146	209
n-Undecane	14	84	120

*Based on > 500 points for each compound.
Compounds listed are the 30 with the highest average concentrations.
Minimum concentrations for all are less than 1 ppbC.

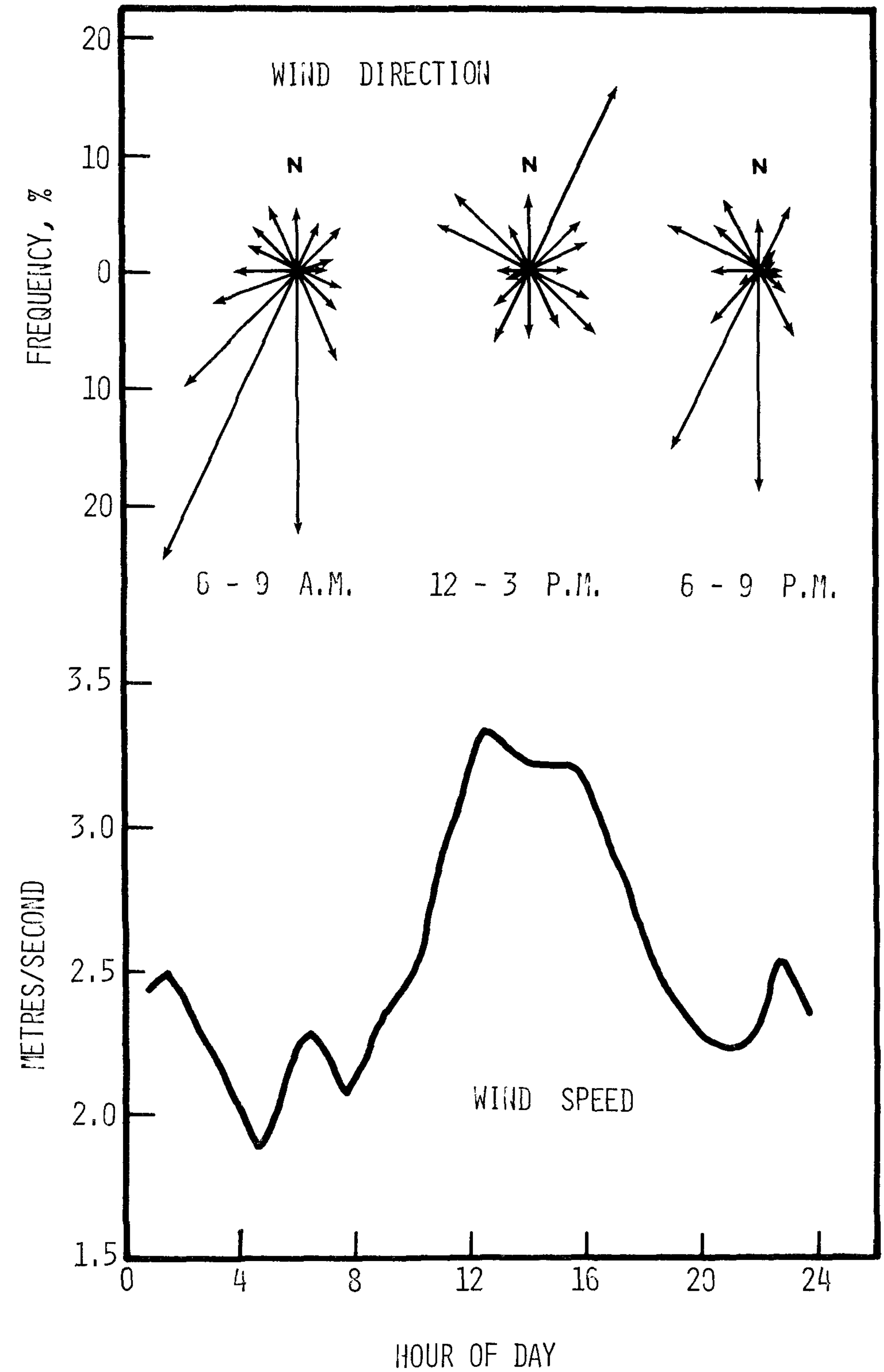

Figure 5. Average Diurnal Variations in Wind.

over 40 days as measured at the CAMP station--mostly in late summer.)[6] The nonmethane hydrocarbon standard of 0.24 ppm (6-9 a.m. average) was exceeded daily--as it is in nearly all metropolitan areas. The NO_2 standard of 0.05 ppm is an annual average and should be compared to the 0.07 ppm average from the ARL data only with the consideration that NO_2 is usually highest during this period. The Federal standards for SO_2 were not exceeded.

It must be emphasized that all pollutant measurements are dependent upon location and instrumentation. CO concentrations measured by the CAMP station in downtown Denver, for example, were consistently higher than those recorded by the ARL, while the reverse was often the case for NO_2.[7] The CO values listed in Table 3 are from the most sensitive and reliable method (flame ionization) which was not available (due to lack of H_2) on November 29 and 30 when a low inversion caused elevated CO levels. The less sensitive nondispersive infrared was operable and gave an average CO concentration of 19 ppm for the 8 hours from 1900 to 0300, exceeding the 9 ppm standard.

Pollutant Patterns

Many primary pollutants exhibited a typical bimodal diurnal variation, as shown in Figures 6 and 7. NO and hydrocarbons first peaked between 0700 and 0800 while the first CO peak was shortly after 0800. Night peaks were around 2000 and were about the same concentrations as the morning peaks. The minima occurred near 1300 for these primary pollutants. (Historical data from downtown Denver show a similar bimodal distribution for CO and traffic density, both of which peak first between 0700 and 0800 and again at 1600 to 1700)[1] Another primary pollutant, SO_2, was always low (<0.03 ppm, 99 percent of the time) and seemed to vary more randomly.

As shown in Figure 8, ozone levels were low to moderate with an afternoon peak averaging just under 0.03 ppm between 1300 and 1400. Except for early morning values (before O_3 levels could build up), the diurnal averages for O_3 and NO seemed to vary inversely. This was also true for short-term, (10 min.) variations of the two. In fact, the diurnal variations for THC, CO, and NO were all similar, with minima occuring near 1300 while O_3, ultraviolet, temperature, and wind speed showed inverted patterns, all with maxima at 1300. Aerosol seemed to correspond with the primary pollutants--the average visibility was greatest at the time of maximum average ozone.

Wind roses, depicting average pollutant concentrations subset by wind direction, are plotted in Figure 9. Average concentrations for most pollutants were greatest with winds from downtown Denver (and especially from the direction of the intersection of highways 70 and 25), but this can be interpreted in several ways since this is also the direction of drainage winds during inversions. In fact, Figure 5 shows that these are the prevailing winds at the times of the average diurnal peaks for these pollutants.

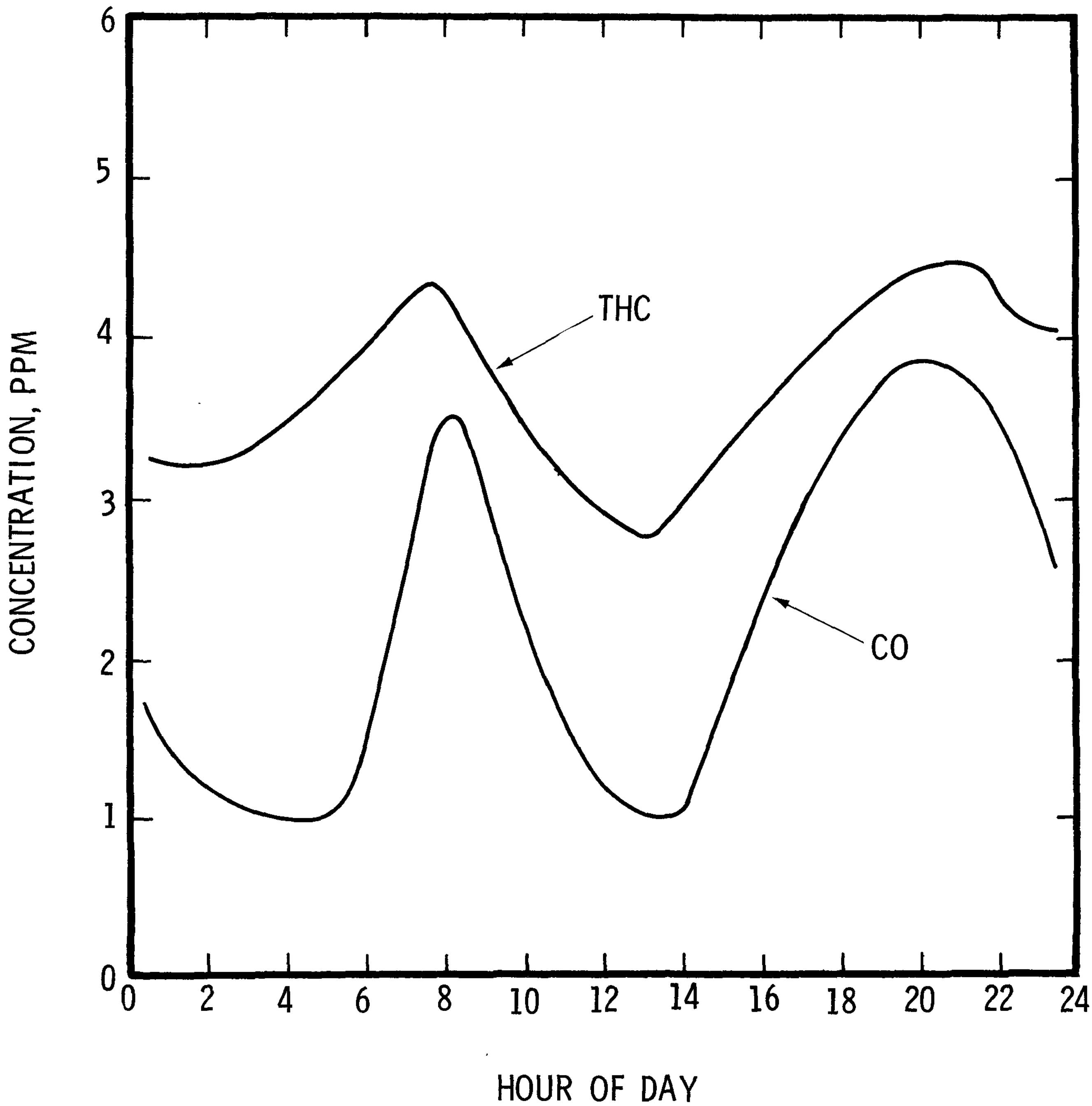

Figure 6. Average Diurnal Variations of THC and CO.

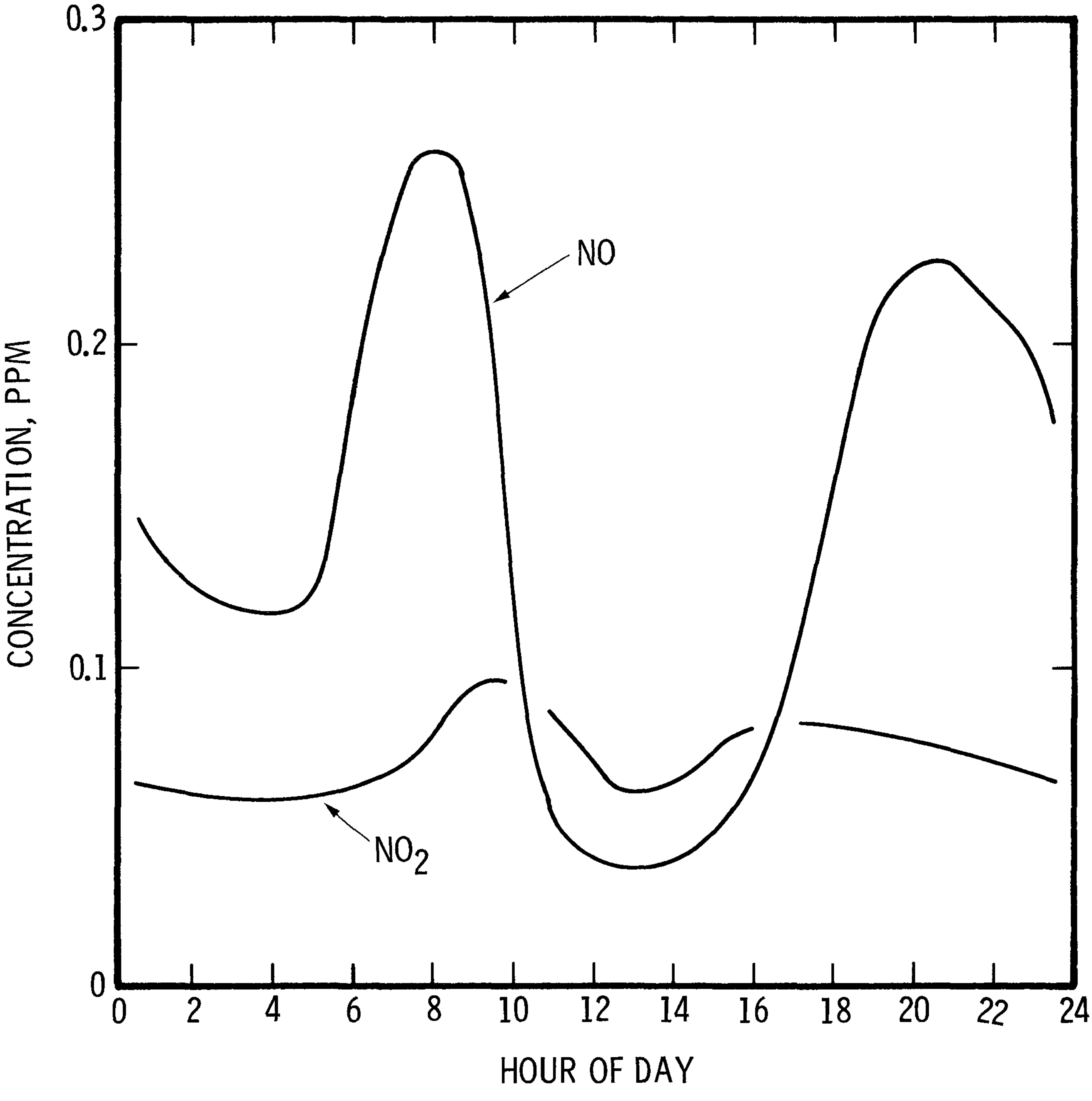

Figure 7. Average Diurnal Variations of NO and NO_2.

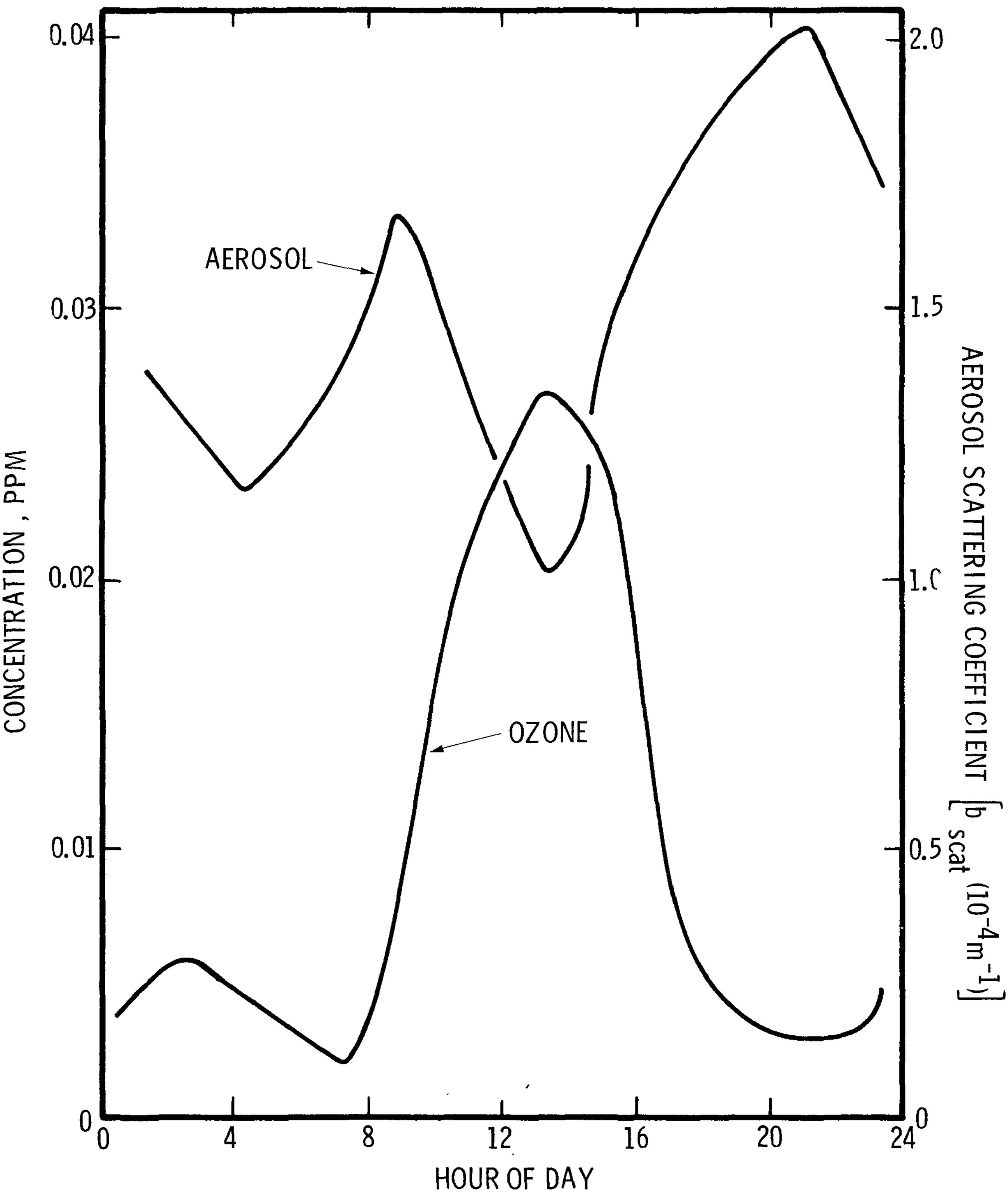

Figure 8. Average Diurnal Variations of Aerosol and O_3

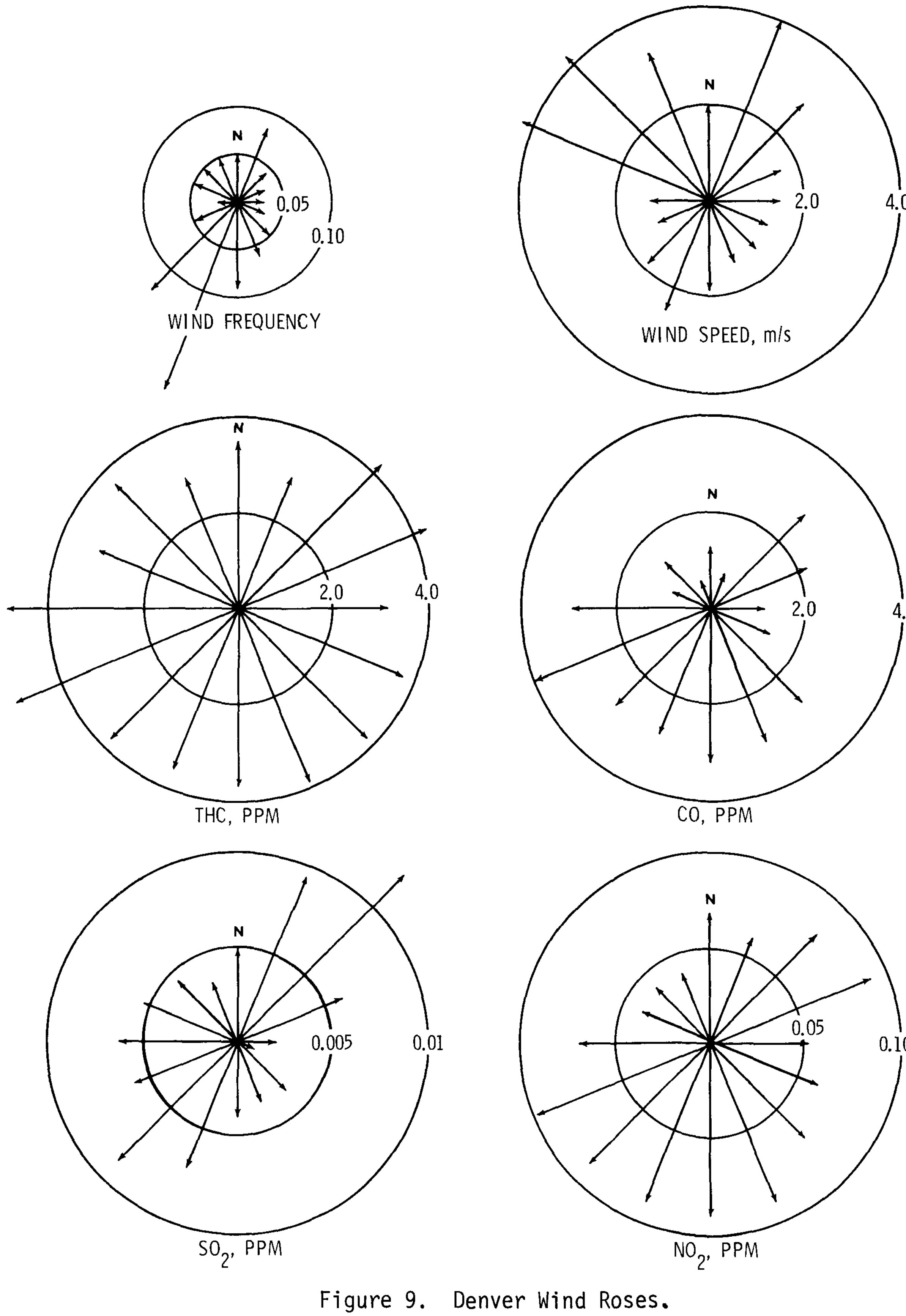

Figure 9. Denver Wind Roses.

Individual hydrocarbon data can be useful for characterizing an air mass and its pollution sources. While many of the more common hydrocarbon pollutants are emitted from a variety of sources, some may be considered representative of specific sources. For example, natural gas is mostly methane with small amounts of ethane and propane. Auto exhaust composition can vary greatly, but mainly consists of methane, ethylene, acetylene, propylene, toluene, and C_4-C_8 paraffins. There may also be a small amount of ethane and traces of propane. Other major sources of atmospheric hydrocarbons include vented vapors from gasoline stations and oil refineries. Pollutants that are emitted from the same source(s) would be expected to correlate well. Table 5 lists correlation coefficients for 9 common hydrocarbons. As expected, compounds such as the methylpentanes and methylhexanes (which are all found in gasoline) correlate very well (0.91-0.96) while acetylene (mainly from auto exhaust) and propane (not in auto exhaust) do not correlate well (0.35). With the exception of propane, all of the hydrocarbons listed in Table 5 are often found in auto exhaust, and their cross-correlations are all high. The heavier compounds (C_6-C_8)are also found in gasoline, and they correlate better with each other than with either ethylene or acetylene. Since the single major source of acetylene in urban atmospheres is auto exhaust, it is often considered a good tracer for exhaust.

Comparisons with Other Cities

The average concentrations for many pollutants were comparable to those found in other large cities. SO_2 values were very low--similar to Los Angeles[3] and about one-fourth those measured in New York City[8] (the ARL monitored in each city during its worst season). The CO values were also low, averaging only 2 ppm, as compared to 5 ppm in West Covina and 7 ppm in New York. Average values for THC (3.7 ppm) and NO_x (0.22 ppm) were found to be very similar in all three cities. The average visibility in Denver (33 km) was better than in New York City (25 km) and much better than in West Covina (17 km).

"Brown Cloud" Episodes

Denver's major air pollution problem centers around the Brown Cloud that settles over the city's northeast sector during severe inversions. The cloud was sometimes seen to slowly travel down and then back up the river valley with the prevailing winds: NNE in the morning, then occasionally returning in the afternoon. One of several episodes encountered during this period in which this reversal was very noticeable occurred on December 1, and several parameters are plotted in Figure 10. Morning winds were low and from the south-southwest. Pollutant levels were relatively high, and the Brown Cloud could be seen over north Denver. By late morning, however, winds increased and the cloud blew by, leaving clean, clear air over the city even though the brown haze could be seen to persist for hours downriver. At 1420, the wind abruptly shifted 180° to NNE and increased in speed. The dew point jumped 8°C, and the temperature (which had been at its maximum for the six-week period) began to fall rapidly. Within minutes the cloud was seen to return and

TABLE 5. CORRELATION COEFFICIENTS FOR VARIOUS HYDROCARBONS

Correlation coefficients x 100 -- Based on 477 runs

		1	2	3	4	5	6	7	8
1	Ethylene								
2	Acetylene	95							
3	Propane	35	36						
4	2-Methylpentane	76	74	61					
5	3-Methylpentane	70	68	63	93				
6	2-Methylhexane	81	79	51	93	92			
7	3-Methylhexane	72	71	53	92	91	96		
8	Toluene	79	79	39	77	72	80	76	
9	O-Xylene	82	80	35	80	79	89	84	79

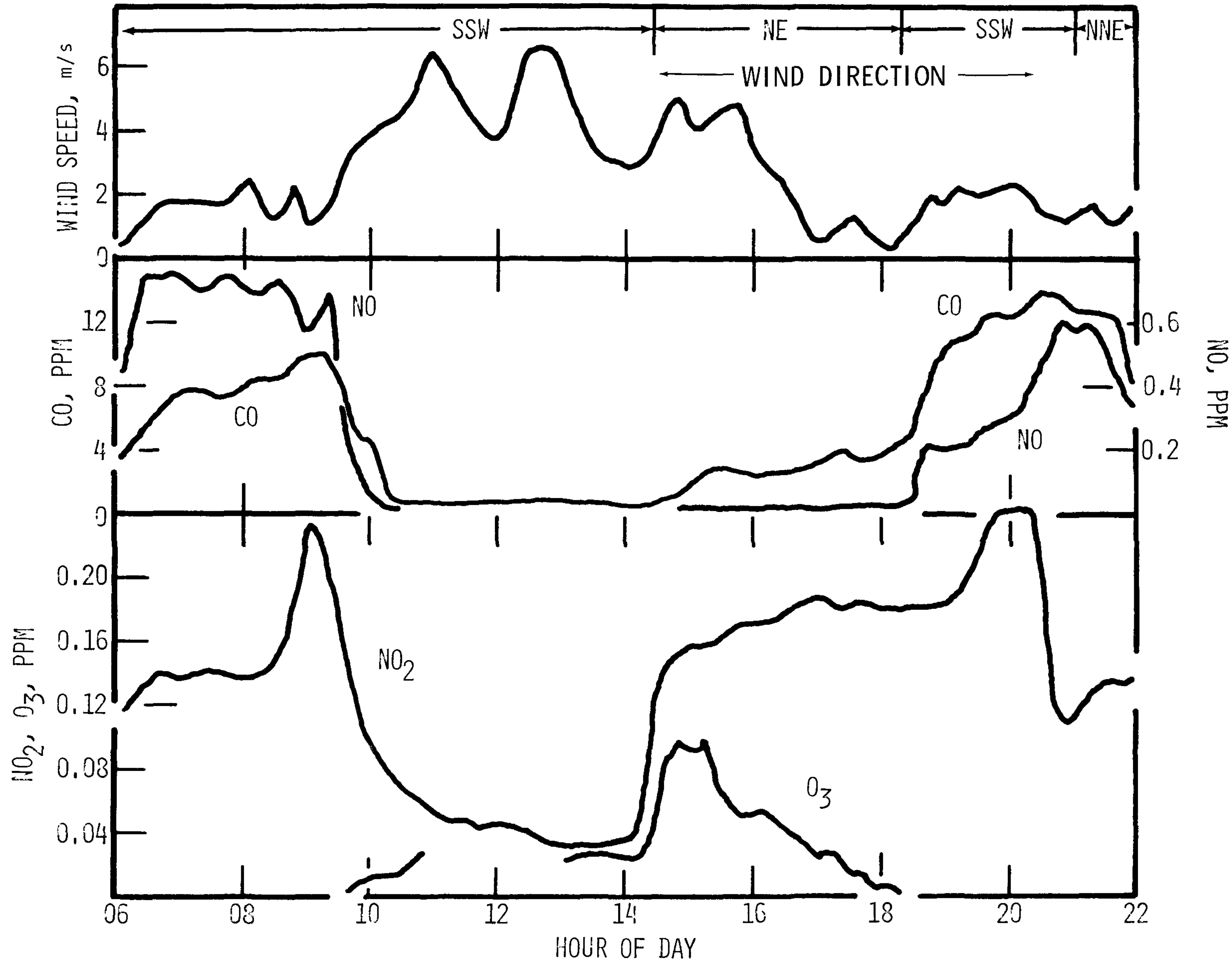

Figure 10. 'Brown Cloud' Episode of December 1, 1973.

pollutant levels jumped even higher than morning values, but with a somewhat different composition. Total hydrocarbon levels were essentially the same, while the CO concentration was reduced by more than 75 percent. There were high concentrations of O_3 and NO_2, but very low levels of NO as expected in an aged and photochemically reacted air mass. The change in hydrocarbon composition, however, cannot be explained simply by aging. The afternoon air mass showed a large increase in nonexhaust alkanes, as seen by the propane/acetylene and butane/acetylene ratios listed in Table 6. The 9 percent decrease in the ethylene/acetylene ratio, if significant, may reflect some photochemical activity (as indicated by the high concentrations of ozone); but photochemistry alone cannot account for the very large increases in the ratios of propane and butane to acetylene. As shown in Table 6, the visibility was poor and the THC (rich in alkanes), was high. But the low concentrations of both CO and acetylene imply that only a small percentage of the pollutants in the air mass can be attributed to auto exhaust--a percentage supported by the low concentration of CO.

At 1820, the wind again reversed direction and blew from the SSW. NO_2 and aerosol concentrations continued high while CO and NO increased; all peaked around 2000 (coinciding with the typical evening peak). Hydrocarbon compositions also showed an increase in exhaust-related pollutants, as expected from the change in wind direction.

Another episode with reduced visibility occurred on the morning of November 21, when the Brown Cloud could be seen over the ARL. At 0925, about half of the total hydrocarbons could be assigned to auto exhaust as indicated in Table 6. By 1025, the levels of CO and acetylene fell, while THC rose from the large input of nonexhaust hydrocarbons. The nephelometer peaked at 1025 with 5.2 km, the lowest visibility for this episode. As seen in Table 6, for this time the ratios of propane and butane to acetylene had increased several times over those for the previous hour and the exhaust fraction was reduced to 21 percent of the total. By 1125, the cloud was beginning to blow west and all pollutant levels started to fall.

The episode of December 1 may be considered as the end of a three-day episode in which pollutant levels started to build up on the night of November 28. As indicated earlier, CO concentrations were very high during the period, but lack of hydrogen prevented measurements of hydrocarbons until noon on November 30. Table 6 lists data taken at 1245, 1345, and 1445. During these three hours, concentrations of exhaust-related hydrocarbons decreased while those of nonexhaust hydrocarbons increased and the total remained remarkably constant at 7 ppmC. By 1445, auto exhaust could account for only about 4 percent of the 7.2 ppmC of total hydrocarbons.

Composition of the "Brown Cloud"

The chief cause of haze and reduced visibility is usually light scattering by aerosols in the 0.1-1μm-size range.[13] Particulates were

TABLE 6. COMPOSITION OF "BROWN CLOUD" FOR THREE EPISODES

	Time	Visibility (km)	THC* (ppmC)	CO* (ppm)	Ethylene/ Acetylene (Vol.)	Propane/ Acetylene (Vol.)	n-Butane/ Acetylene (Vol.)	Acetylene x 20/ THC (apx. % auto exhaust)**
	0845	9	8.3	9.7	1.0	1.0	1.0	57
Dec. 1	1545	6	8.1	2.3	0.9	13.7	5.9	11
	1945	5	10.4	11.8	1.0	2.2	1.3	42
	0925	8	6.5	5.1	0.8	1.4	1.4	48
Nov. 21	1025	5	10.6	4.7	1.1	5.1	4.9	21
	1125	9	3.6	1.4	0.7	1.0	0.9	44
	1245	12	7.1	2.4	0.8	1.8	3.1	24
Nov. 30	1345	18	7.0	1.5	0.8	3.8	2.1	9
	1445	27	7.2	1.4	0.9	10.5	6.0	4

* from Beckman 6800 gas chromatograph
**based on vol. % C_2H_2 in exhaust of about 10%.

not measured by the ARL in Denver, but some data are available from sampling conducted by several groups during both the 1971 and 1973 studies.[9-12] Using a variety of analytical techniques (including visual and X-ray microscopy and optical emission spectroscopy) on samples from both studies, it was concluded that particulate loadings are moderately high but only about 20 percent anthropogenic. Of special interest, both toxicologically and aesthetically, are submicron particles. The MRI aircraft study in 1973 indicated that fresh combustion particulates (< 0.1 μm) are found in the inversion layer in fresh plumes high in NO.[9] As the plume "ages," NO is oxidized to NO_2, O_3 builds up, and particles are formed in the 0.1 to 1.0 μm light-scattering range. Particles in this size range correlate well with nephelometer data and with local visibility.[13] Ruud and Williams[11] analyzed the back-up filter for November 16, 1973 and attributed 57 percent of the fine particles to auto emissions, 8 percent fly ash, and about 33 percent soil and minerals.

Draftz and Durham[10] analyzed five days of data from November, 1971. Each day's total loads exceeded the 75 μg/m³ annual geometric mean standard, but none approached the 24-hour standard of 260 μg/m³. They concluded that more than 25 percent of the fine-sized particulates were lead salts from auto exhaust. They reported that total lead concentrations on five membrane filters varied from 1.7 to 4.9 μg/m³. This corresponds to about 3 to 8 μg/m³ of the salts which, alone, would be expected to give nearly unlimited visibility (45 km).[13-14] The analytical techniques employed did not quantitatively measure (or, in some cases, even indicate) most organic and nonmetallic aerosols (such as sulfates which may be much more abundant than lead). The elements they identified alone accounted for about one-fourth of the total mass. By calculating the mass of the most common compounds in which those elements are found (as indicated in the text), one can account for about half of the total mass.

This figure (50 percent) can be compared with the results reported by Willeke and Whitby for filter samples also taken in the Denver area in November 1971. They found that "about 30 percent of the submicron mass consists of benzene-soluble organics during clean days and over 50 percent during polluted days."[12] Not considering organics, Draftz and Durham concluded that aerosol composition remained unchanged from clean days to polluted days. With more information now available, it appears that the pollutant composition of Denver's air may vary considerably--not just from clean days to polluted days but even from hour to hour during severe episodes (as seen from Table 6).

With the possibility of large variations in composition, the single greatest problem of the Brown Cloud is its noticeability. The topography and meteorology of the Denver area tend to concentrate the urban plume over a well-defined area where it is in sharp contrast to surrounding clean air.[4,5] Yet, the visibility measured in one of the worst areas--at the ARL--was better than 17 km for 90 percent of the time and poorer than 10 km for only 3 percent of the period (which is historically the season of highest particulate loads).

The Brown Cloud phenomenon may be due to both light scattering and absorption. NO_2 levels measured in Denver are sufficient to cause a brown color which would be more noticeable when there are low aerosol concentrations.[15] In the inversion layer measured by the MRI aircraft downwind of the city on the morning of November 20, NO_x (most of which was NO_2 at that location) was off-scale at more than 0.5 ppm, while the nephelometer indicated a minimum visibility of over 15 km. With concentrations of SO_2 at 0.3 ppm and CO at only 3 ppm,[9] the origin of the pollutants in the plume was predominantly nonautomotive. From ARL data, ratios of CO/NO_x vary greatly but are generally less than expected in auto exhaust. A volumetric ratio of CO/NO_x of about 70:1 would be expected from auto exhaust in Denver for 1973.[16] The ratios measured by the ARL during episodes usually varied from 10:1 to 20:1, indicating large nonautomotive sources of NO_x.

Other than its appearance, there seems to be no unique characterization of the Brown Cloud. Its composition (as indicated especially by the hydro-carbon and CO data) was seen to vary considerably--sometimes rich in automotive pollutants, and sometimes poor; sometimes high in ozone and other times not. No one factor can be considered the cause of the Brown Cloud--unless it is the frequent periods of stable atmospheric conditions during which strong inversions and low surface winds concentrate all pollutants in a relatively small volume with sharp visual boundaries between it and surrounding cleaner air.

ACKNOWLEDGMENT

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Appendix A. DENVER POLLUTANT AND METEOROLOGICAL DATA
(Hourly Averages)

Site: 4958 York, Denver, Colorado
Sampling tube 10 m above ground
November 4 - December 14, 1973

Hourly averages given where at least half of the data points (5-minute averages of one minute voltage readings) exist in the hour.

HOUR	Hour of the day (Mountain Standard Time)
VWDR	Vector average wind direction (0 and 360° are north)
VWSP	Vector average wind speed (m/s)
WSPD	Scalar wind speed (m/s)
WSIG	Wind Sigma (degrees)
TEMP	Temperature (degrees Centigrade)
DWPT	Dew Point (degrees Centigrade)
RH	Relative humidity (percent)
RAIN	Precipitation last hour (mm of H_2O)
UV	Ultraviolet (mJ/cm^2s)
NEPH	Integrating nephelometer (scattering coefficient, $10^{-4}m^{-1}$)
CO	Carbon monoxide (ppm) from Beckman 6800 (preferred)
*CO	Carbon monoxide (ppm) from Beckman 315BL NDIR
HC	Total hydrocarbon (ppm carbon atoms) from Beckman 400
THC	Total hydrocarbon (ppm carbon atoms) from Beckman 6800 (preferred)
CH4	Methane (ppm)
NMHC	Nonmethane hydrocarbons (ppm carbon atoms)
SO2	Sulfur atoms (ppm)
*NO2	Nitrogen dioxide (ppm) by Saltzman technique
NO2	Nitrogen dioxide (ppm) by chemiluminescence [NO_x-NO] (preferred)
NO	Nitric oxide (ppm)
NOX	Total nitrogen oxides (ppm)
OXID	Oxidant, Mast meter with SO_2 scrubber (ppm)
O3	Ozone, by chemiluminescence (ppm)

DENVER, COLO.
NOV 4,1973

HOUR	VWDR	VWSP	WSPD	WSIG	TEMP	DWPT	RH	RAIN	UV	NEPH	CC	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
12																							
13																							
14													1.9										
15													2.1										
16													2.3										
17													2.1										
18	359	0.9	1.0	9	-4	-7	83		0.00			2.3	2.0									0.003	0.007
19	358	0.8	0.9	11	-4	-6	86		0.00			2.6	2.1									0.000	0.003
20	356	0.7	0.9	10	-4	-6	87		0.00			2.8	2.2									0.000	0.000
21	15	0.7	0.8	13	-4	-5	88		0.00			2.7	2.4									0.000	0.000
22	360	1.0	1.1	8	-4	-6	86		0.00			2.6	2.0									0.000	0.000
23	10	2.5	2.6	6	-3	-6	82		0.00			2.2	1.9									0.000	0.010

DENVER, COLO.
NOV 5,1973

HOUR	VWDR	VWSP	WSPD	WSIG	TEMP	DWPT	RH	RAIN	UV	NEPH	CC	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	357	1.9	2.0	7	-4	-6	81		0.00			1.8	1.8									0.000	0.026
01	22	1.3	1.5	7	-3	-6	83		0.00			1.6	1.9									0.000	0.025
02	58	0.6	0.8	19	-4	-5	88		0.00			1.6	2.0									0.000	0.018
03	77	0.8	0.9	14	-3	-5	87		0.00			1.7	2.4									0.000	0.007
04	24	0.9	1.1	14	-3	-5	86		0.00			1.8	2.6									0.000	0.001
05	170	1.8	2.0	12	-3	-6	82		0.00			2.0	2.2									0.000	0.000
06	187	1.8	2.0	7	-3	-7	76		-0.01			2.4	2.2									0.000	0.020
07	165	2.1	2.2	8	-3	-7	75		0.10			3.2	2.5									0.000	0.002
08	171	2.6	2.7	6	-2	-7	71		0.47			2.9	2.4									[illegible]	0.010
09	180	2.2	2.4	8	0	-5	66		1.16			3.1	2.5									0.002	0.025
10	348	1.4	1.8	11	4	-4	57		1.36			3.9	2.9									0.008	0.035
11	335	0.8	1.1	19	6	-4	52		1.43			3.7	2.7									0.017	0.051
12	295	0.5	0.9	27	8	-2	49		1.35			3.8	3.2									0.035	0.044
13	270	0.6	1.3	17	8	-3	47		1.07			4.4	2.9									0.033	0.041
14	36	2.4	2.5	6	5	-2	58		0.61			4.9	3.6									0.042	0.049
15	28	2.7	2.8	6	5	-2	62		0.34													0.054	0.060
16	31	2.6	2.7	7	3	-3	67		0.03				2.9									0.037	0.055
17	52	1.2	1.3	11	1	-4	74		0.01	4.0			3.5									0.014	0.037
18	0	0.8	1.1	11	-0	-4	77		0.01	5.0			3.6									0.013	0.038
19	358	1.0	1.2	15	-1	-4	78		0.01	5.8			3.4									0.000	0.000
20	72	0.8	1.3	16	-1	-5	77		0.01	5.6			3.8									0.000	0.000
21	104	0.6	1.1	26	-2	-5	79		0.01	5.7			4.1									0.000	0.000
22	35	0.4	1.5	17	-2	-5	79		0.01	6.0			4.5									0.000	0.000
23	99	0.5	0.9	32	-2	-5	79		0.01	6.3			4.7									0.000	0.000

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DENVER, COLO.
NOV 6,1973

HOUR	VWDR	VWSP	WSPD	WSIG	TEMP	DWPT	RH	RAIN	UV	NEPH	CC	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	188	1.0	1.5	24	-2	-5	80		0.01	6.1			4.9									0.001	0.000
01	222	2.5	2.7	9	-1	-4	80		0.01	6.9			5.6									0.014	0.000
02	177	1.2	1.7	17	-0	-4	80		0.01	4.7			4.3									0.004	0.000
03	221	1.4	2.0	18	0	-3	78		0.01	3.8			3.8									0.001	0.000
04	260	0.6	1.4	29	0	-4	75		0.01	3.1			4.1									0.000	0.000
05	145	0.9	1.8	19	0	-4	73		0.01	2.5			5.4									0.000	0.000
06	72	0.7	1.7	27	1	-4	70		-0.01	1.5			4.3									0.002	0.000
07	24	1.0	1.6	19	2	-3	69		0.12	1.8			7.3									0.007	0.000
08	265	0.4	1.7	22	4	-3	65		0.48	2.1			6.4									0.[illegible]	0.000
09	237	0.9	1.5	22	7	-1	55		0.72	3.1			6.5									0.021	0.000
10	258	0.6	1.1	20	11	-1	46		0.94	3.1			5.5									0.016	0.001
11																							

DENVER, COLO.
NOV 10,1973

OUR	VWDR	VWSP	WSPD	WSIG	TEMP	DWPT	RH	RAIN	UV	NEPH	CC	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
14																							
15																							
16	28	2.6	2.7	4	15	6	56	-0.2	-0.00														
17	191	0.9	1.3	16	13	5	59	0.0	-0.00			5.6										0.001	0.000
18	201	2.0	2.0	8	13	4	53	0.0	-0.00			10.5										0.012	0.000
19	176	1.4	1.7	3	13	-0	41	0.0	-0.00			13.3										0.011	0.000
20	185	1.4	1.7	16	10	-1	47	0.1	-0.00			8.3										0.004	0.000
21	168	1.3	1.3	5	8	-2	52	0.1	-0.00	1.3		8.2	4.0				0.005					0.003	0.000
22	183	1.4	1.6	5	7	-3	51	0.0	-0.00	1.4		7.3	3.5				0.005					0.002	0.000
23	238	0.9	1.1	10	5	-3	55	0.0	-0.00	1.7		9.3	4.4				0.006					0.014	0.000

DENVER, COLO.
NOV 11,1973

HOUR	VWDR	VWSP	WSPD	WSIG	TEMP	DWPT	RH	RAIN	UV	NEPH	CO	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	199	0.9	1.0	16	4	-3	59	0.0	-0.00	1.7		9.0	4.7				0.005					0.013	0.000
01	216	1.3	1.3	3	4	-3	60	0.0	-0.00	1.9		11.1	5.6				0.005					0.022	0.000
02	233	1.3	1.3	6	3	-3	64	0.0	0.00	2.1		10.4	5.7				0.005					0.026	0.000
03	232	1.0	1.2	7	2	-4	65	-0.1	0.00	2.0		9.1	5.7				0.004					0.023	0.000
04	223	0.6	0.9	12	2	-4	66	0.0	0.00	1.9		7.4	5.9				0.005					0.020	0.000
05	250	0.3	0.5	19	1	-4	70	0.0	0.00	1.8		6.6	6.0				0.005					0.016	0.000
06	245	0.9	1.0	9	1	-4	72	0.0	-0.01	1.5		4.6	5.2				0.005					0.011	0.000
07	197	1.5	1.7	6	4	-3	62	0.0	0.16	1.6		4.1	4.3				0.005					0.012	0.000
08	226	1.2	1.6	14	10	-3	40	0.0	0.63	1.4		4.6	4.1				0.005					0.005	0.000
09	279	0.6	0.9	15	16	-3	29	0.0	1.10	1.3		4.2	3.2				0.007					0.005	0.001
10	341	0.7	0.9	12	19	-4	21	0.0	1.26	1.1		3.0	2.9				0.016					0.007	0.002
11	26	1.7	1.8	8	19	-3	23	-0.1	1.49	1.3		2.7	3.2				0.017					0.022	0.017
12	31	2.2	2.3	7	19	-1	26	0.0	1.52	1.7		3.2	3.8				0.023					0.045	0.039
13	19	2.4	2.5	8	20	-1	24	0.0	1.30	1.4		3.8	2.8				0.020					0.045	0.047
14	22	2.5	2.6	6	20	-0	27	0.0	0.78	1.4		2.7	2.2				0.009					0.025	0.030
15	27	3.0	3.0	5	19	1	31	0.0	0.40	1.5		2.4	2.5				0.006					0.017	0.023
16	16	1.5	1.7	8	16	0	36	0.0	0.02	1.7		2.0	2.2				0.006					0.007	0.013
17	106	0.2	0.7	12	13	1	43	-0.1	0.00	2.1		3.7	3.1				0.006					0.000	0.000
18	180	1.0	1.1	10	11	1	51	0.0	0.00	2.8		11.5	6.0				0.007		0.10	0.47	0.57	0.018	0.000
19	196	1.4	1.5	5	10	1	57	0.2	0.00	3.5		17.1	7.1				0.006		0.12	0.51	0.62	0.024	0.000
20	190	2.3	2.4	4	10	1	56	0.0	0.00	3.9		9.1	4.7				0.009	0.11	0.14	0.31	0.45	0.013	0.000
21	202	1.5	1.6	9	9	0	57	0.0	0.01	4.0		5.2	3.8				0.015	0.12	0.15	0.23	0.37	0.008	0.000
22	224	1.6	1.8	8	8	-0	58	0.0	0.01	3.6		5.1	4.0				0.011	0.12	0.14	0.23	0.36	0.007	0.000
23	202	0.7	1.0	21	7	-1	57	0.0	0.00	4.1		6.7	4.8				0.008	0.13	0.13	0.34	0.47	0.017	0.000

DENVER, COLO.
NOV 12,1973

HOUR	VWDR	VWSP	WSPD	WSIG	TEMP	DWPT	RH	RAIN	UV	NEPH	CO	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	212	1.9	2.1	9	7	-1	57	0.0	0.00	3.2		7.1	4.5				0.008	0.13	0.13	0.37	0.49	0.020	0.000
01	223	1.4	1.8	12	7	-2	54	0.0	0.00	2.5		5.4	4.1				0.007	0.12	0.10	0.33	0.42	0.014	0.000
02	213	1.2	1.8	10	7	-3	52	0.0	0.00	2.0		4.5	4.8				0.007	0.11	0.08	0.28	0.36	0.010	0.000
03	223	1.1	1.5	18	6	-2	54	0.0	0.00	1.7		3.7	4.9				0.007	0.09	0.08	0.26	0.33	0.007	0.000
04	220	1.6	1.9	9	6	-3	53	0.0	0.00	1.4		3.2	4.4				0.006	0.08	0.07	0.24	0.31	0.004	0.000
05	219	2.0	2.2	10	7	-4	46	0.0	0.00	1.2		3.0	3.8				0.006	0.07	0.08	0.24	0.31	0.004	0.000
06	220	2.2	2.4	4	7	-5	44	0.0	-0.01	1.6		6.3	4.2				0.007	0.08	0.09	0.40	0.49	0.014	0.000
07	212	2.6	2.8	5	9	-6	36	0.0	0.08	2.1		10.6	4.7				0.012	0.09	0.09	0.57	0.66	0.022	0.000
08	220	1.4	1.7	8	11	-6	31	-0.1	0.49	2.5		13.5	5.2				0.016	0.11	0.13	0.54	0.67	0.021	0.000
09	203	4.2	4.2	4	17	-7	18	0.0	1.02	0.9		4.4	3.0				0.022	0.09	0.09	0.18	0.26	0.000	0.001
10	200	5.0	5.0	3	17	-7	19	0.1	0.53	0.9		3.2	2.4					0.07	0.07	0.14	0.20	0.000	0.001
11	203	3.6	3.7	5	17	-7	19	0.0	0.62	0.8		2.8	2.3					0.06	0.06	0.07	0.13	0.000	0.002
12	187	2.6	2.7	7	19	-6	19	0.0	0.60	1.1		2.7	2.3					0.06	0.05	0.06	0.11	0.000	0.003
13	157	1.5	1.6	8	19	-4	20	0.0	0.62	1.2		4.4	2.8					0.07	0.07	0.09	0.16	0.000	0.002
14	33	2.0	2.0	10	20	-2	22	-0.1	0.58	2.2		6.0	6.5					0.12	0.14	0.07	0.21	0.022	0.017
15	33	1.6	1.6	7	20	-2	23	-0.1	0.33	1.6		4.9	4.7					0.11	0.11	0.06	0.16	0.013	0.014
16	9	1.0	1.1	6	18	-2	27	0.0	0.00	2.5		7.8	4.2					0.12	0.12	0.15	0.27	0.002	0.001
17	261	0.3	0.7	19	14	-1	37	0.0	-0.00	3.0		12.2	7.3				0.014	0.11	0.12	0.30	0.42	0.012	0.000
18	181	1.7	1.8	11	13	-0	41	0.0	0.00	5.1		29.8	11.4				0.014	0.15	0.16	0.77	0.92	0.051	0.000
19	193	2.3	2.5	6	14	-2	32	0.0	0.00	2.4		13.5	5.5				0.016	0.12	0.11	0.34	0.45	0.015	0.000
20	222	2.2	2.5	8	15	-4	28	0.1	0.00	1.2		4.6	3.4				0.014	0.08	0.06	0.15	0.21	0.001	0.000
21	286	0.2	1.0	15	12	-4	33	0.0	0.00	1.3		5.7	6.3				0.015	0.08	0.06	0.17	0.23	0.001	0.000
22	213	0.8	1.3	20	10	-3	42	0.0	0.00	2.3		8.6	9.5				0.018	0.08	0.05	0.33	0.38	0.015	0.000
23	208	2.2	2.3	8	10	-3	41	0.0	0.00	2.3		8.7	5.1				0.009	0.10	0.07	0.36	0.43	0.016	0.000

DENVER, COLO.
NOV 13,1973

HOUR	VWDR	VWSP	WSPD	WSIG	TEMP	DWPT	RH	RAIN	UV	NEPH	CO	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	239	1.6	1.8	8	11	-4	38	0.0	0.00	1.8		5.6	4.1				0.009	0.09	0.07	0.26	0.33	0.009	0.000
01	283	3.0	3.1	4	12	-4	33	0.0	0.00	1.0		1.6	4.5				0.010	0.06	0.05	0.07	0.11	0.001	0.001
02	263	1.9	2.8	6	14	-3	31	0.0	0.00	0.8		0.7	2.0				0.006	0.03	0.03	0.02	0.05	0.005	0.006
03	113	2.0	2.1	7	11	-4	35	0.0	0.00	0.9		1.5	2.5				0.005	0.06	0.05	0.04	0.08	0.000	0.000
04	79	0.9	1.6	24	6	-3	51	0.0	0.01	0.7		0.8	3.3				0.004	0.03	0.03	0.02	0.05	0.000	0.001
05	345	0.6	1.0	24	3	-3	64	0.0	0.01	0.9		0.4	4.3				0.005	0.04	0.04	0.05	0.09	0.000	0.000
06	31	0.7	1.1	27	2	-3	71	0.0	-0.00	1.4		1.7	7.7				0.006	0.04	0.04	0.12	0.15	0.000	0.000
07	31	0.9	1.3	23	4	-2	68	0.0	0.11	1.5		2.6	7.0				0.006	0.05	0.05	0.13	0.18	0.000	0.000
08	20	0.8	1.0	21	9	-0	54	-0.1	0.54	2.1		3.2	11.7				0.007	0.12	0.12	0.03	0.15	0.060	0.028
09	54	1.2	1.4	11	13	1	43	0.2	0.96	3.7		5.1	11.7					0.17	0.19	0.04	0.22	0.116	0.056
10	18	3.4	3.4	5	16	1	36	0.0	1.31	2.5		3.7	6.0					0.12	0.11	0.04	0.15	0.062	0.034
11	18	4.9	5.0	4	18	1	33	0.0	1.53	1.0		1.7						0.05	0.04	0.04	0.08	0.013	0.016
12	8	5.1	5.2	5	19	-0	27	-0.1	1.49	0.7		1.5	1.9					0.03				0.016	0.021
13	337	6.1	6.2	6	20	1	29	0.1	1.22	0.8		2.2	1.8				0.013	0.02				0.009	0.015
14	324	7.1	7.2	5	19	1	30	0.2	0.83	0.7		2.2	1.7				0.008		0.02	0.03	0.05	0.009	0.018
15	316	5.4	5.4	7	16	-1	33	-0.3	0.30	0.6		2.0	1.7				0.005		0.02	0.02	0.04	0.009	0.016
16	323	4.5	4.6	7	13	-0	40	0.0	-0.00	0.8		1.9	1.7				0.005		0.03	0.02	0.05	0.008	0.015
17	357	1.0	1.6	13	11	-1	43	0.0	-0.00	0.8		2.4	2.0				0.006		0.05	0.05	0.10	0.000	0.004
18	357	0.6	1.0	13	10	-1	47	0.0	-0.00	1.0		1.9	2.2				0.013	0.07	0.06	0.09	0.15	0.002	0.002
19	334	1.8	1.8	8	9	-2	47	0.0	-0.00	0.9		1.1	1.7				0.012	0.05	0.05	0.07	0.12	0.001	0.003
20	336	0.4	0.9	15	8	-2	49	0.0	0.00	0.8		1.4	2.3				0.008	0.04	0.04	0.02	0.06	0.001	0.004
21	114	0.7	0.8	10	6	-2	55	0.0	0.01	1.1		4.0	3.4				0.008	0.05	0.06	0.14	0.20	0.004	0.000
22	162	1.7	1.9	4	6	-2	58	0.0	0.01	1.6		6.8	4.1				0.006	0.06	0.05	0.18	0.23	0.004	0.000
23	170	1.2	1.2	6	5	-2	64	0.0	0.01	1.6		6.1	3.6				0.004	0.06	0.06	0.18	0.24	0.003	0.000

DENVER, COLO.
NOV 14,1973

HOUR	VWDR	VWSP	WSPC	WSIC	TEMP	DWPT	RH	PAIN	HV	NEPH	CO	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	209	1.1	1.4	9	3	-2	68	0.0	0.01	1.9		6.1	4.3				0.005	0.06	0.06	0.23	0.29	0.007	0.000
01	312	0.5	1.2	22	2	-2	73	0.0	0.01	2.4		6.9	7.4				0.007	0.06	0.06	0.25	0.31	0.009	0.000
02	4	0.3	1.1	22	2	-2	77	0.0	0.01	2.3		6.4	10.2				0.010	0.06	0.05	0.23	0.28	0.006	0.000
03	62	1.7	1.9	7	1	-3	77	0.0	0.00	1.7		4.6	6.0				0.007	0.06	0.05	0.18	0.23	0.003	0.000
04	126	0.7	1.1	21	-0	-3	78	0.0	-0.00	1.0		1.7	4.1				0.005	0.05	0.04	0.06	0.10	0.000	0.000
05	226	1.9	2.0	6	0	-3	80	0.0	-0.00	1.1		2.7	3.8				0.006	0.06	0.05	0.13	0.19	0.001	0.000
06	226	1.5	1.8	9	1	-3	78	0.0	-0.01	1.7		5.7	4.0				0.006	0.08	0.08	0.33	0.40	0.014	0.000
07	196	1.4	1.6	13	3	-2	73	0.0	0.10	2.1		11.1	5.2				0.007	0.10	0.06	0.45	0.52	0.024	0.000
08	189	0.7	1.0	19	7	-1	57	0.0	0.49	3.0		11.9					0.009	0.14	0.14	0.34	0.48	0.020	0.000
09	179	1.5	1.7	16	11	-1	44	-0.1	0.92	1.7		5.0						0.12	0.12	0.10	0.21	0.009	0.008
10	249	2.0	2.4	16	14	-2	34	0.3	1.24	1.9		4.0	2.6				0.010	0.12	0.12	0.05	0.16	0.018	0.021
11	271	7.6	7.8	7	15	-14	13	0.1	1.67	1.5		0.8	1.7				0.006	0.03	0.03	0.01	0.04	0.015	0.028
12	284	7.1	7.5	6	14	-14	13	0.1	1.33	0.9		0.9	2.1				0.032	0.02	0.02	0.01	0.03	0.021	0.037
13	301	5.9	6.0	7	14	-12	17	-0.2	1.17	0.7		1.1	2.2				0.008	0.02	0.02	0.02	0.03	0.023	0.041
14	304	6.3	6.5	7	13	-12	17	0.2	0.80	0.6		1.5	2.2				0.007	0.01	0.02	0.02	0.04	0.023	0.042
15	302	6.0	6.1	5	12	-10	21	0.0	0.39	0.7		1.8	2.4				0.008	0.02	0.02	0.02	0.05	0.018	0.038
16	304	5.4	5.6	5	8	-7	33	-0.1	0.01	0.8		1.8	2.2				0.007	0.03	0.04	0.03	0.06	0.012	0.030
17	270	4.5	4.8	6	6	-7	37	0.2	-0.01	0.8		2.1	2.5				0.007	0.05	0.05	0.03	0.08	0.006	0.020
18	290	4.5	4.7	5	6	-7	40	-0.4	-0.00	0.8		1.4	3.0				0.007	0.03	0.03	0.02	0.05	0.013	0.029
19	288	5.1	5.1	6	6	-8	38	0.3	-0.00	0.7		1.1	2.2				0.007	0.03	0.03	0.02	0.04	0.014	0.031
20	287	6.0	6.1	4	7	-10	30	0.1	-0.01	0.7		0.8	2.4				0.006	0.01	0.01	0.01	0.03	0.020	0.037
21	283	7.5	7.8	4	6	-12	28	0.1	-0.01	0.7		0.8	2.6				0.007	0.02	0.01	0.01	0.03	0.017	0.035
22	265	5.9	6.0	6	5	-12	28	0.0	-0.00	0.6		0.8	1.7				0.006	0.03	0.02	0.01	0.04	0.012	0.029
23	260	5.9	5.9	6	4	-12	29	-0.1	-0.00	0.6		0.8	1.7				0.006	0.03	0.03	0.01	0.04	0.012	0.029

DENVER, COLO.
NOV 15,1973

HOUR	VWDR	VWSP	WSPD	WSIG	TEMP	DWPT	RH	RAIN	UV	NEPH	CO	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	268	6.5	6.6	5	4	-13	28	0.1	-0.00	0.6		0.7	1.6				0.005	0.02	0.02	0.01	0.03	0.013	0.030
01	283	5.8	6.1	6	4	-14	27	-0.1	-0.00	0.5		0.3	2.2				0.006	0.01	0.01	0.01	0.02	0.019	0.036
02	294	6.4	6.6	6	4	-14	27	-0.1	-0.00	0.5		0.4	2.5				0.006	0.01	0.01	0.01	0.02	0.020	0.036
03	308	5.2	5.3	4	4	-14	27	0.0	-0.00	0.4		0.4	2.0				0.006	0.01	0.01	0.01	0.01	0.024	0.039
04	281	2.7	3.3	10	4	-15	25	0.0	-0.00	0.5		0.5	2.4				0.006	0.03	0.03	0.01	0.04	0.015	0.026
05	332	2.1	2.5	15	3	-15	27	0.0	-0.00	0.5		0.2	1.9				0.006	0.03	0.03	0.02	0.05	0.012	0.024
06	223	2.3	2.4	5	0	-14	33	0.0	-0.01	0.9		2.6	2.6				0.008	0.07	0.07	0.18	0.25	0.000	0.000
07	205	3.4	3.4	4	1	-12	41	0.0	0.10	1.0		5.0	3.1				0.007	0.08	0.07	0.18	0.25	0.000	0.000
08	197	3.6	3.7	5	4	-12	33	-0.2	0.51	1.5		4.5	2.9				0.027	0.09	0.08	0.40	0.48	0.010	0.000
09	193	3.4	3.5	5	7	-12	26	0.0	0.99	1.3		2.6	2.6					0.10	0.09	0.16	0.25	0.004	0.005
10	157	1.9	2.2	11	8	-13	23	-0.3	1.02	0.9		1.9	2.2					0.08	0.07	0.04	0.11	0.009	0.016
11	145	3.1	3.3	11	10	-14	18	0.2	1.41	0.6		0.7	2.0					0.03	0.03	0.02	0.04	0.017	0.028
12	146	3.2	3.4	10	11	-15	14	0.0	1.44	0.5		0.7	1.8				0.006	0.02	0.02	0.01	0.03	0.024	0.036
13	125	2.9	3.2	9	12	-16	13	-0.1	1.18	0.5		1.1	1.9				0.005	0.02	0.02	0.01	0.03	0.024	0.037
14	143	3.9	4.1	8	13	-16	13	-0.1	0.79	0.6		0.5	1.8				0.005	0.03				0.021	0.030
15	135	4.2	4.3	5	11	-16	14	0.2	0.28	0.5		1.0	1.8				0.005	0.03	0.03	0.02	0.05	0.010	0.022
16	110	2.1	2.1	5	9	-16	16	0.0	0.00	1.0		5.6	2.9				0.007	0.07	0.07	0.13	0.21	0.000	0.001
17	25	0.6	1.2	11	6	-15	21	0.0	-0.01	1.5		8.4	4.1				0.009	0.07	0.07	0.27	0.35	0.000	0.000
18	255	0.2	0.3	14	3	-13	30	0.0	-0.01	1.9		5.9	5.4				0.012	0.05	0.07	0.25	0.32	0.000	0.000
19	180	0.7	0.8	9	3	-12	33	0.0	-0.00	2.1		10.4	6.1				0.011	0.07	0.07	0.42	0.50	0.007	0.000
20	206	1.9	2.0	3	3	-12	35	0.0	-0.00	2.1		13.5	5.5				0.012	0.09	0.09	0.57	0.67	0.016	0.000
21	203	1.9	2.1	10	2	-11	37	0.1	-0.00	1.4		5.7	3.5				0.009	0.08	0.07	0.23	0.31	0.001	0.000
22	211	4.9	5.1	5	3	-12	35	0.0	-0.00	1.4		4.4	3.2				0.028	0.07	0.07	0.23	0.30	0.000	0.000
23	181	2.3	3.0	17	2	-13	34	0.0	-0.00	1.1		2.8	2.5				0.017	0.07	0.06	0.12	0.18	0.000	0.001

DENVER, COLO.
NOV 16,1973

HOUR	VWDR	VWSP	WSPD	WSIG	TEMP	DWPT	RH	PATN	UV	NEPH	CO	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	123	0.4	1.7	30	1	-13	36	0.0	-0.00	1.1		2.5	3.0				0.014	0.06	0.06	0.11	0.17	0.000	0.001
01	165	1.0	1.4	20	0	-12	38	0.0	-0.00	1.0		2.2	2.9				0.013	0.06	0.06	0.10	0.16	0.000	0.000
02	191	0.4	0.6	16	-1	-13	42	0.0	-0.00	1.1		2.5	3.2				0.011	0.07	0.06	0.14	0.20	0.000	0.000
03	194	3.0	3.1	4	-0	-11	44	0.0	-0.00	1.0		1.5	2.8				0.017	0.07	0.06	0.12	0.18	0.000	0.000
04	213	1.5	2.0	15	1	-11	42	0.0	-0.00	0.8		1.1	3.4				0.027	0.07	0.06	0.08	0.14	0.000	0.001
05	210	1.4	1.6	8	-0	-11	45	0.0	-0.00	0.9		2.0	3.1				0.011	0.08	0.07	0.13	0.20	0.000	0.000
06	198	1.1	1.3	12	1	-10	44	0.0	-0.01	1.2		4.8	3.5				0.012	0.08	0.08	0.26	0.34	0.003	0.002
07	237	0.7	0.9	14	1	-10	44	0.0	0.03	2.3		10.8	4.8				0.012	0.10	0.10	0.55	0.66	0.020	0.000
08	2	0.6	0.7	17	1	-9	47	-0.2	0.32	3.6		14.2	8.9				0.014	0.12	0.12	0.67	0.79	0.031	0.000
09	28	1.4	1.6	12	6	-6	41	-0.1	0.91	2.4		7.5	5.7				0.019	0.13	0.15	0.24	0.40	0.021	0.011
10	6	1.0	1.1	21	13	-7	26	-0.2	1.16	2.9		6.2	5.9				0.029		0.23	0.05	0.27	0.060	0.051
11	22	3.0	3.1	7	13	-7	24	0.1	1.28	2.3		4.2	3.6				0.066		0.16	0.20	0.36	0.007	0.005
12	26	4.0	4.1	6	13	-7	24	0.0	1.34	1.3		2.3	2.7				0.040		0.09	0.09	0.17	0.003	0.011
13	28	3.5	3.5	6	15	-7	22	0.0	1.15	1.2		2.4	3.9				0.037		0.07	0.04	0.11	0.014	0.026
14	30	3.4	3.4	7	17	-12	14	0.2	0.76	0.9		2.3	2.8				0.022		0.04	0.02	0.04	0.020	0.038
15	38	2.7	2.8	6	16	-13	13	-0.2	0.32	0.9		2.5	2.5				0.017	0.04	0.05	0.03	0.08	0.014	0.033
16	89	0.7	0.8	12	13	-15	13	0.0	0.00	1.1	2.5	5.8	3.5	3.4	1.9	1.5	0.012	0.08	0.08	0.09	0.17	0.001	0.009
17	125	0.9	1.0	8	10	-13	20	0.0	-0.01	1.3	5.7	8.1	3.6	3.9	1.9	2.1	0.012	0.09	0.08	0.22	0.31	0.000	0.001
18	187	0.7	0.8	15	8	-11	26	0.0	-0.01	1.2	5.2	7.0	3.3	3.7	1.7	2.0	0.010	0.11	0.08	0.18	0.26	0.000	0.002
19	216	0.5	0.5	5	7	-12	26	0.0	-0.01	1.8	8.7	12.5	4.8	4.8	1.9	2.9	0.012	0.12	0.06	0.37	0.43	0.005	0.002
20	230	1.1	1.1	5	5	-12	30	0.0	-0.01	2.6		15.4	6.0	6.3	2.2	4.1	0.014	0.14	0.00	0.55	0.56	0.017	0.001
21	203	0.4	0.5	9	3	-12	34	0.0	-0.00	2.2	8.7	10.1	6.1	6.7	3.2	3.5	0.017	0.13	0.07	0.38	0.46	0.007	0.001
22	179	0.5	0.5	15	2	-11	38	0.3	-0.00	2.5	9.2	11.0	5.4	5.7	2.6	3.1	0.014	0.13	0.06	0.50	0.57	0.014	0.001
23	200	1.0	1.1	6	1	-11	41	0.0	-0.00	2.3	7.8	8.9	4.7	4.9	2.4	2.6	0.020	0.12	0.09	0.34	0.43	0.006	0.001

DENVER, COLO.
NOV 17,1973

HOUR	VWDR	VWSP	WSPD	WSIG	TEMP	DWPT	RH	RAIN	UV	NEPH	CO	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	192	1.4	1.5	7	1	-11	41	0.0	-0.01	1.9	6.0	6.8	4.0	4.4	2.2	2.2	0.023	0.11	0.09	0.26	0.34	0.002	0.001
01	201	1.9	2.1	6	0	-12	41	0.0	-0.01	1.6	4.0	5.1	3.3	3.6	1.9	1.7	0.035	0.10	0.08	0.19	0.27	0.000	0.000
02	223	1.5	1.6	10	-0	-12	43	0.0	-0.01	1.9	3.8	4.9	4.2	4.4	2.5	1.9	0.016	0.10	0.08	0.25	0.33	0.002	0.000
03	191	0.2	1.4	21	-2	-12	49	0.0	-0.01	1.9	4.7	5.6	5.7	6.0	4.1	1.8	0.014	0.11	0.08	0.30	0.38	0.004	0.000
04	200	1.1	1.5	14	-2	-12	48	0.0	-0.00	1.4	3.3	4.3	4.5	4.7	3.1	1.6	0.013	0.10	0.08	0.23	0.31	0.001	0.000
05	215	1.9	2.1	7	-2	-11	48	0.0	-0.00	1.9	4.4	5.3	4.8	5.0	2.9	2.1	0.013	0.13	0.10	0.35	0.45	0.009	0.000
06	220	0.8	1.1	20	-2	-12	46	0.0	-0.01	1.7	5.1	5.5	4.6	4.9	2.8	2.1	0.012	0.13	0.10	0.35	0.45	0.009	0.000
07	187	2.4	2.4	4	0	-12	41	-0.3	0.07	1.2	4.0	4.6	3.6	3.8	2.1	1.7	0.027	0.11	0.07	0.26	0.34	0.003	0.000
08	190	3.5	3.7	5	6	-15	23	0.1	0.49	0.8	1.8	2.3	2.4	2.6	1.6	1.0	0.021	0.09	0.06	0.06	0.12	0.000	0.005
09	214	1.5	1.9	11	10	-14	18	0.1	0.94		2.0			3.1	1.5	1.6	0.015	0.10	0.08	0.08	0.16	0.002	0.007
10	187	1.6	1.7	13	14	-13	15	-0.2	1.35		1.5	2.3		2.4	1.3	1.0		0.08				0.022	0.026
11	161	1.0	1.3	22	16	-12	14	-0.1	1.36	0.6		1.5	2.1				0.012	0.03	0.02	0.01	0.03	0.034	0.040
12	140	0.7	1.2	24	17	-11	14	0.0	1.46	0.5		1.3	1.8				0.011	0.02	0.02	0.02	0.04	0.039	0.047
13	85	1.3	1.8	38	16	-11	14	0.0	1.12	0.5		2.1	1.9				0.011	0.02	0.02	0.03	0.05	0.040	0.053
14	100	0.7	0.9	25	16	-12	15	0.1	0.69	0.6		2.5	1.9				0.013	0.03	0.03	0.04	0.08	0.034	0.050
15	296	3.6	3.8	9	15	-13	14	0.0	0.27	0.5		2.6	2.9				0.012	0.01	0.02	0.04	0.06	0.028	0.049
16	300	5.5	5.6	5	14	-13	15	-0.1	-0.00	0.6		2.2	3.2				0.013	0.01	0.02	0.04	0.06	0.022	0.041
17	305	5.4	5.5	4	13	-12	17	0.3	-0.01	0.5		1.8	2.5				0.013	0.01	0.02	0.04	0.06	0.019	0.037
18	285	3.6	3.8	5	11	-13	18	0.1	-0.01	0.5	0.4	1.8	3.8	3.1	2.0	1.1	0.012	0.03	0.03	0.03	0.06	0.014	0.030
19	228	1.5	2.5	6	9	-13	20	0.0	-0.01	0.8	1.5	3.2	2.7	3.7	3.0	0.7	0.010	0.07	0.07	0.07	0.14	0.003	0.010
20	164	2.0	2.3	6	7	-12	25	0.0	-0.01	0.9	2.1	3.7	2.6	2.7	1.5	1.2	0.010	0.08	0.08	0.09	0.16	0.000	0.003
21	178	3.0	3.1	3	5	-11	31	0.0	-0.01	1.1	3.0	4.4	2.7	2.8	1.5	1.3	0.010	0.08				0.000	0.003
22	209	2.3	2.3	4	3	-10	37	-0.1	-0.01	1.4	2.8	4.6	2.9	2.9	1.5	1.4	0.010	0.07	0.07	0.14	0.21	0.000	0.002
23	204	2.1	2.1	2	3	-10	38	0.0	-0.01	1.4	3.6	5.3	3.3	3.3	1.7	1.6	0.011	0.08	0.07	0.16	0.23	0.000	0.001

DENVER, COLO.
NOV 18,1973

HOUR	VWDR	VWSP	WSPD	WSIG	TEMP	DWPT	RH	RAIN	UV	NEPH	CC	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	208	0.9	1.4	9	2	-10	40	0.0	-0.01	1.4	3.5	5.1	3.5	3.5	1.8	1.7	0.021	0.08	0.07	0.17	0.24	0.000	0.001
01	196	1.8	1.9	6	1	-11	41	0.0	-0.01	1.1	2.9	4.3	3.1	3.1	1.7	1.5	0.013	0.08	0.07	0.19	0.26	0.000	0.001
02	191	1.2	1.3	11	1	-11	43	0.0	-0.01	1.1	3.4	5.0	3.5	3.5	1.8	1.7	0.017	0.08	0.07	0.18	0.26	0.000	0.001
03	186	1.2	1.4	11	0	-11	45	0.0	-0.00	1.0	3.1	4.8	3.5	3.3	1.8	1.5	0.018	0.08	0.07	0.14	0.21	0.000	0.001
04	216	1.0	1.4	16	-0	-10	48	0.0	-0.00	1.2	3.0	4.9	3.8	3.7	2.0	1.7	0.012	0.08	0.08	0.21	0.29	0.000	0.001
05	351	0.1	0.5	23	-1	-10	52	0.0	-0.00	1.5	3.1	5.3	5.9	5.1	3.2	1.9	0.011	0.09	0.08	0.26	0.34	0.003	0.001
06	38	0.1	0.7	21	-2	-10	56	0.0	-0.01	1.5	3.2	5.3	12.7	10.2	10.4	3.5	0.023	0.08	0.07	0.28	0.36	0.005	0.001
07	308	0.2	0.9	16	-2	-9	60	0.0	0.05	1.6	3.2	5.3	12.1	11.3	10.3	1.8	0.018	0.08	0.07	0.27	0.34	0.004	0.001
08	251	0.9	1.2	9	3	-6	50	-0.2	0.47	1.6	3.5	5.8	8.1	6.9	4.9	2.0	0.016	0.11	0.11	0.29	0.40	0.009	0.002
09	326	0.1	0.5	22	11	-6	32	0.0	0.85	1.5	2.7	4.0	3.6	3.8	2.2	1.6	0.014	0.13	0.12	0.14	0.26	0.005	0.005
10	17	2.1	2.1	5	9	-8	30	0.0	0.84	1.6	1.4	3.5	3.8	3.7	1.7	2.0	0.040		0.14	0.06	0.20	0.014	0.016
11	22	3.5	3.6	5	10	-6	32	0.2	1.15	1.3	0.6	2.4	2.6	2.6	1.3	1.3	0.044					0.004	0.012
12	21	4.3	4.4	5	10	-6	34	0.0	1.18	1.2	0.4	2.1	2.2	2.2	1.2	1.0	0.020					0.010	0.020
13	16	3.8	3.9	7	10	-5	34	0.1	1.13	1.2	0.3	2.3	2.3	2.4	1.3	1.1	0.017	0.02				0.014	0.025
14	13	3.1	3.2	6	11	-5	33	0.0	0.73	1.2	0.4	2.6	2.5	2.5	1.3	1.2	0.018	0.01	0.04	0.03	0.07	0.017	0.029
15	6	2.2	2.4	7	11	-5	33	0.1	0.30	1.2	0.3	3.2	2.6	2.6	1.3	1.3	0.017	0.01	0.05	0.04	0.09	0.013	0.027
16	335	1.3	1.3	7	9	-6	34	-0.1	-0.01	1.1	0.5	3.7	2.2	2.3	1.2	1.1	0.016	0.01	0.06	0.04	0.11	0.001	0.013
17	243	0.3	0.4	8	5	-7	42	0.1	-0.02	1.2	1.5	5.6	5.0	4.9	3.5	1.4	0.018	0.02	0.07	0.14	0.21	0.001	0.003
18	258	0.5	0.6	7	3	-6	49	0.0	-0.01	1.7	5.9	10.1	6.5	4.8	3.8	1.8	0.020	0.03	0.08	0.37	0.45	0.007	0.003
19	311	0.4	0.7	26	3	-6	55	0.0	-0.01	2.2	6.6	11.0	9.9	9.1	5.3	3.7	0.021	0.03	0.08	0.37	0.45	0.009	0.003
20	193	1.0	1.3	6	2	-5	58	-0.1	-0.01	2.8	7.4	14.3	11.4	8.1	6.8	2.3	0.024	0.04	0.07	0.59	0.66	0.024	0.003
21	224	0.5	1.5	8	1	-6	61	0.1	-0.01	3.1	6.8	13.6	8.6	7.6	3.9	3.7	0.016	0.05	0.09	0.57	0.66	0.024	0.002
22	182	2.6	2.7	2	2	-5	60	0.0	-0.01	3.3	9.7	13.8	6.3	6.2	2.7	3.6	0.014	0.06	0.09	0.53	0.63	0.023	0.002
23	224	1.2	1.6	15	2	-5	59	0.0	-0.01	4.0	11.2	17.0	7.4	6.8	2.9	4.0	0.013	0.08	0.12	0.71	0.84	0.037	0.002

DENVER, COLO.
NOV 19,1973

HOUR	VWDR	VWSP	WSPD	WSIG	TEMP	DWPT	RH	RAIN	UV	NEPH	CC	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	43	1.1	1.6	17	1	-6	61	0.0	-0.01	2.7	4.4	8.2	6.4	5.6	3.0	2.5	0.014	0.04	0.08	0.29	0.37	0.007	0.002
01	357	0.5	1.5	28	-0	-7	63	0.0	-0.01	2.5	4.6	7.9	7.1	6.9	3.4	3.5	0.015	0.04	0.08	0.28	0.35	0.006	0.001
02	287	0.7	1.0	16	-1	-6	68	0.0	-0.01	1.8	2.1	4.6	9.1	6.6	5.8	1.6	0.018	0.03	0.06	0.14	0.20	0.000	0.001
03	278	0.7	1.0	14	-1	-7	66	0.0	-0.01	1.2	0.8	3.3	10.2	7.4	9.0	0.1	0.020	0.02	0.05	0.06	0.11	0.000	0.002
04	115	1.2	1.4	7	-1	-7	62	0.0	-0.01	1.4	1.2	4.0	6.5	6.2	4.7	1.4	0.014	0.03	0.06	0.10	0.16	0.000	0.003
05	196	0.8	1.2	13	-1	-7	64	0.0	-0.01	1.5	1.7	4.8	4.0	3.7	2.1	1.7	0.012	0.03	0.06	0.16	0.23	0.000	0.002
06	223	1.2	1.5	4	-1	-7	65	0.0	-0.01	1.9	4.6	8.5	4.5	4.4	2.2	2.2	0.013	0.05	0.09	0.42	0.51	0.016	0.002
07	354	1.3	1.6	8	2	-6	58	0.0	-0.02	1.5	2.9	5.9	4.3	4.3	2.6	1.8	0.014	0.03	0.07	0.21	0.28	0.003	0.003
08	19	3.0	3.3	6	4	-5	55	0.0	0.17	1.3	2.3	5.0	3.9	3.3	1.4	1.8	0.017	0.05	0.06	0.11	0.17	0.001	0.006
09	50	3.1	3.2	6	4	-4	60	-0.1	0.36	1.2	0.8	2.2	3.0	2.9	1.2	1.7	0.017	0.03	0.04	0.04	0.07	0.000	0.009
10	58	2.8	3.0	7	3	-3	63	0.1	0.19	1.2	0.6	1.5	2.4	2.5	1.3	1.2	0.010	0.02	0.02	0.03	0.06	0.001	0.009
11	35	3.9	4.1	6	2	-3	67	0.0	0.11	1.3	0.8	1.2	2.5	3.0	1.3	1.7	0.011	0.01	0.02	0.04	0.05	0.000	0.007
12	22	6.8	6.8	4	1	-4	69	0.1	0.06	1.0	0.4	0.8	2.2	2.4	1.2	1.2	0.009	0.00	0.02	0.03	0.05	0.000	0.005
13	24	6.7	6.7	4	-0	-4	73	0.1	0.02	1.0	0.4			2.4	1.2	1.2	0.009	-0.00	0.01	0.03	0.04	0.000	0.002
14	20	7.0	7.0	4	-1	-5	79	0.1	-0.01	0.9	0.5	0.8	2.0	2.3	1.2	1.1	0.008	-0.01	0.01	0.03	0.05	0.000	0.000
15	13	6.9	7.0	4	-2	-5	81	0.0	-0.02	0.9	0.5	0.9	2.1	2.4	1.3	1.0	0.008	-0.01	0.01	0.03	0.04	0.000	0.000
16	11	6.4	6.5	4	-3	-6	81	0.1	-0.02	1.0	0.7	0.9	2.0	2.3	1.3	1.0	0.008	-0.01	0.02	0.02	0.03	0.000	0.000
17	15	7.1	7.1	4	-4	-7	84	0.0	0.01	0.8	0.6	1.0	2.0	2.3	1.3	1.0	0.008	-0.01	0.01	0.01	0.03	0.000	0.002
18	22	5.7	5.7	4	-5	-6	88	0.0	0.01	0.8	0.4	0.7	2.0	2.2	1.2	0.9	0.009	0.00	0.01	0.01	0.02	0.000	0.004
19	32	6.2	6.3	4	-5	-6	90	-0.1	0.01	0.8	0.2	0.2	2.4	2.6	1.3	1.4	0.011	0.01	0.01	0.01	0.02	0.000	0.005
20	27	6.9	6.9	4	-5	-7	89	0.1	0.01	0.8	0.1	0.1	2.2	2.5	1.2	1.3	0.009	0.01	0.01	0.01	0.02	0.004	0.011
21	29	6.2	6.2	4	-5	-7	90	0.2	0.00	0.8	0.1	0.4	2.2	2.4	1.2	1.2	0.010	0.01	0.02	0.01	0.03	0.006	0.014
22	29	4.8	4.8	5	-5	-7	91	0.0	0.00	0.8	0.2	0.7	2.4	2.5	1.2	1.4	0.011	0.02	0.02	0.01	0.02	0.008	0.016
23	19	3.5	3.5	5	-5	-6	92	0.0	0.00	0.7	0.2	0.8	1.9	2.2	1.2	1.0	0.009	0.02	0.02	0.01	0.03	0.010	0.018

DENVER, COLO.
NOV 20,1973

HOUR	VWDR	VWSP	WSPD	WSIG	TEMP	DWPT	RH	RAIN	UV	NEPH	CO	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	20	4.2	4.2	4	-5	-6	91	0.0	0.00	0.7	0.1	0.9	1.8	2.1	1.2	1.0	0.010	0.01	0.02	0.01	0.02	0.008	0.017
01	26	2.1	2.2	8	-5	-6	94	0.0	0.00	0.8	0.1	0.7	2.2	2.4	1.3	1.1	0.009	0.02	0.02	0.01	0.03	0.008	0.017
02	23	0.6	0.7	15	-5	-5	101	0.0	0.00	0.9	0.1	0.9	2.1	2.3	1.3	1.0	0.009	0.03	0.03	0.01	0.04	0.005	0.014
03	98	1.5	1.6	13	-5	-6	95	0.0	0.00	1.0	0.3	1.4	2.5	2.7	1.7	1.0	0.009	0.03	0.03	0.01	0.04	0.005	0.013
04	161	1.2	1.5	8	-6	-7	94	0.0	0.00	1.0	0.4	1.2	2.1	2.2	1.3	1.0	0.008	0.05	0.05	0.01	0.06	0.000	0.001
05	213	0.6	0.8	18	-6	-6	100	0.0	0.00	1.3	0.5	1.4	2.4	2.5	1.4	1.1	0.009	0.06	0.06	0.02	0.08	0.000	-0.003
06	13	1.8	2.0	9	-5	-6	93	0.0	-0.01	1.1	0.6	1.4	2.6	2.8	1.5	1.4	0.010	0.05	0.05	0.02	0.07	0.002	0.005
07	144	1.0	1.2	16	-6	-6	95	0.0	0.06	0.9	1.1	2.4	2.4	2.5	1.4	1.1	0.009	0.05	0.05	0.03	0.08	0.001	0.005
08	190	1.5	1.7	8	-4	-5	93	-0.1	0.52	1.1	1.5	2.5	2.5	2.6	1.2	1.4	0.011	0.06	0.06	0.04	0.09	0.007	0.012
09	173	1.8	1.9	8	-1	-3	89	1.2	1.02	1.1	1.4	2.4	2.5	2.6	1.2	1.5	0.014	0.07	0.07	0.02	0.09	0.028	0.034
10	160	2.2	2.4	9	-1	-4	82	-0.2	1.43	1.3	1.6	2.7	2.4	2.7	1.2	1.5	0.011	0.07	0.07	0.02	0.09	0.036	0.037
11	135	2.1	2.2	10	-0	-4	76	-0.1	1.61	1.3	1.8	2.8	2.3	2.4	1.2	1.3	0.009		0.06	0.02	0.09	0.036	0.040
12	137	2.1	2.3	9	0	-6	64	-0.1	1.50	1.3	1.4	2.8	2.1	2.2	1.1	1.1	0.009		0.06	0.01	0.08	0.049	0.059
13	152	1.6	1.8	13	1	-7	55	0.1	1.20	1.2	1.3	2.8	2.3	2.2	1.1	1.1		0.06	0.06	0.02	0.09	0.037	0.050
14	121	1.6	1.7	11	1	-7	57		0.78	1.5	1.9	4.1	2.5	2.5	1.1	1.4	0.008	0.09	0.11	0.04	0.15	0.024	0.034
15	135	1.7	1.8		1	-7	58		0.35	1.4	2.1			2.5	1.1	1.4			0.12	0.04	0.15	0.017	0.021
16	177	3.0	3.0		0	-9	53		0.05	1.4	2.8			3.0	1.2	1.9			0.10	0.05	0.15	-0.004	-0.002
17	180	2.8	2.8		-1	-9	55		0.02	1.4	4.7			3.5	1.2	2.2			0.11	0.13	0.24	-0.007	-0.009
18	192	2.9	3.0		-2	-9	58		0.03	2.0	5.8			4.0	1.4	2.6			0.12	0.25	0.37	0.001	-0.010
19	183	3.7	3.8		-3	-10	60		0.03	2.2	4.5			3.7	1.5	2.2			0.12	0.23	0.36	0.000	-0.010
20	172	2.4	2.6		-5	-11	63		0.03	2.0	4.0			3.3	1.3	2.0			0.10	0.17	0.27	-0.008	-0.009
21	155	2.0	2.1		-6	-12	65		0.03	2.0	3.3			3.2	1.4	1.8			0.09	0.15	0.23	-0.008	-0.010
22	184	2.3	2.5		-6	-12	67		0.02	2.1	3.5			3.1	1.3	1.8			0.10	0.15	0.25	-0.008	-0.010
23	190	1.8	1.9		-6	-12	65		0.03	1.6	2.4			2.8	1.3	1.5			0.10	0.10	0.20	-0.008	-0.010

DENVER, COLO.
NOV 21,1973

HOUR	VWDP	VWSP	WSPD	WSIG	TEMP	DWPT	RH	RAIN	UV	NEPH	CO	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	159	1.5	1.7		-5	-11	65		0.01	1.0	1.5			2.7	1.3	1.4			0.08	0.05	0.13	-0.007	-0.010
01	126	0.5	1.3		-5	-11	65		0.01	1.2	1.7			3.6	1.9	1.7			0.09	0.11	0.20	-0.007	-0.010
02	103	0.2	1.2		-6	-11	66		0.01	1.2	2.7			4.5	2.3	2.2			0.09	0.13	0.22	-0.007	-0.009
03	21	0.3	1.1		-6	-11	67		0.01	1.6	2.6			7.4	4.5	2.9			0.08	0.18	0.26	-0.006	-0.009
04	91	0.5	0.9		-6	-11	69		0.01	1.4	2.1			6.7	3.9	2.8			0.08	0.17	0.25	-0.007	-0.010
05	337	0.9	1.2		-7	-11	72		0.00	1.6	1.6			4.5	2.0	2.5			0.08	0.17	0.25	-0.006	-0.009
06	67	1.3	1.5		-7	-11	73		0.01	2.0	2.8			5.9	2.4	3.4			0.10	0.22	0.33	-0.001	-0.009
07	100	1.3	1.4		-5	-10	69		0.06	2.3	3.7			3.9	1.9	2.0			0.10	0.18	0.28	-0.005	-0.009
08	353	0.3	1.2		-1	-8	59		0.36	2.8	3.0			3.6	1.5	2.1			0.12	0.14	0.26	-0.001	-0.005
09	18	1.1	1.2		2	-7	51		0.75	5.6	5.7			7.0	3.0	4.1			0.28	0.15	0.43	0.031	0.011
10	28	1.6	1.7		3	-7	49		1.10	7.8	5.0			8.4	1.8	6.6			0.32	0.07	0.39	0.109	0.086
11	61	1.5	1.7		6	-8	38		1.38	4.2	3.2			3.6	1.3	2.3			0.21	0.05	0.27	0.055	0.048
12	69	1.8	2.0	11	8	-8	32	0.2	1.44	0.9	0.8	1.3	2.3	2.6	1.2	1.3	0.004	0.06	0.06	0.03	0.09	0.031	0.034
13	118	3.5	3.7	12	5	-11	32	0.1	0.73	0.7	0.6	1.8	2.1	2.2	1.1	1.2	0.000	0.04	0.05	0.03	0.08	0.020	0.029
14	110	2.4	2.7	7	5	-9	37	-0.1	0.41	0.7	0.8	2.0	2.1	2.2	1.0	1.2	0.000	0.05	0.05	0.05	0.09	0.015	0.026
15	103	1.8	2.0	14	4	-8	41	0.1	0.14	0.8	1.6	2.9	2.3	2.6	1.2	1.4	0.000	0.06	0.06	0.06	0.12	0.008	0.017
16	129	2.0	2.0	12	3	-10	41	0.0	-0.01	0.9	2.3	3.7	2.4	2.7	1.2	1.5			0.07	0.06	0.14	0.005	0.011
17	149	1.9	2.0	6	2	-9	46	-0.1	-0.00	1.1	4.6	5.8	3.0	3.2	1.3	1.9	0.000		0.09	0.12	0.21	0.000	-0.001
18	127	1.1	1.2	7	1	-9	48	0.0	-0.00	1.3	4.5	7.4	3.4	3.5	1.4	2.0	0.004		0.09	0.19	0.28	0.003	-0.002
19	63	1.0	1.2	12	1	-8	53	0.0	-0.00	1.5	5.5	7.1	4.2	4.5	1.7	2.8	0.000		0.09	0.26	0.35	0.007	-0.002
20	151	0.7	1.7	16	-1	-9	57	0.0	-0.00	1.3	2.7	4.3	3.0	3.1	1.4	1.7	0.000		0.09	0.13	0.22	0.000	-0.002
21	12	2.4	2.6	6	-2	-8	64	0.0	-0.00	1.2	1.9	2.1	2.7	3.1	1.4	1.7	0.000		0.07	0.10	0.17	0.000	-0.001
22	23	3.1	3.2	5	-3	-8	66	0.0	-0.00	0.9	0.5	0.9	4.0	4.5	1.9	2.6	0.000		0.05	0.03	0.08	0.000	0.005
23	7	2.4	2.7	6	-2	-7	69	0.0	-0.00	0.8	0.1	0.6	2.3	2.8	1.5	1.3	0.000		0.03	0.03	0.06	0.008	0.013

DENVER, COLO.
NOV 22,1973

HOUR	VWDR	VWSP	WSPD	WSIG	TEMP	DWPT	RH	RAIN	UV	NEPH	CC	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	11	2.7	2.8	6	-2	-6	71	0.0	-0.00	0.9	0.2	0.8	2.4	2.8	1.3	1.5	0.000		0.03	0.03	0.02	0.009	
01	7	1.7	1.8	6	-3	-6	81	0.0	-0.00	1.0	0.1	0.5	2.2	2.7	1.4	1.3	0.000		0.03	0.02	0.05	0.003	
02	188	1.4	1.5	10	-4	-6	84	0.0	-0.00	2.2	0.3	0.7	2.6	3.0	1.4	1.6	0.003		0.04	0.02	0.06	0.000	
03	229	1.4	1.4	4	-5	-7	85	0.0	-0.00	1.7	0.6	1.0	2.4	2.8	1.5	1.4	0.000		0.06	0.05	0.12	0.000	
04	233	1.1	1.2	6	-5	-7	86	0.0	-0.00	1.9	0.6	2.3	2.4	2.8	1.4	1.4	0.000		0.07	0.09	0.16	0.000	
05	193	0.4	1.1	11	-6	-8	85	0.0	-0.00	1.7	0.7	3.1	4.6	4.1	2.4	1.6	0.003		0.07	0.10	0.16	0.000	
06	193	2.2	2.3	5	-6	-8	83	0.0	-0.00	1.5	0.8	1.8	2.5	2.9	1.6	1.3	0.000		0.06	0.08	0.14	0.000	
07	164	2.0	2.5	16	-5	-8	80	0.0	0.03	1.5	1.0	3.0	2.3	2.7	1.5	1.2	0.000		0.05	0.05	0.10	0.000	
08	170	2.1	2.1	7	-2	-9	62	0.0	0.43	1.1	0.7	1.4	1.9	2.4	1.3	1.1	0.000		0.04	0.03	0.07	0.004	
09	164	2.9	3.1	6	-0	-9	52	0.2	0.77	0.9	0.5	1.5	1.9	2.3	1.2	1.0	0.000		0.04	0.02	0.06	0.012	
10	143	3.2	3.3	8	1	-8	49	-0.1	0.93	0.9		0.4					0.000					0.018	
11	138	4.0	4.1	7	3	-9	44	-0.1	1.43			0.8	1.7						0.02	0.02	0.04	0.021	
12	139	4.8	4.9	8	4	-8	41	-0.2	1.63			0.7	1.7						0.02	0.02	0.03	0.030	
13	141	2.7	2.8	12	5	-7	43	0.1	1.11			0.9	1.7						0.02	0.02	0.04	0.029	
14	110	2.2	2.4	11	5	-6	43	-0.1	0.76			1.4	1.8				0.000		0.02	0.03	0.05	0.034	
15	79	2.8	2.9	13	5	-6	48	0.0	0.29	0.5	0.2	1.0	1.9	2.4	1.4	1.0	0.000		0.02	0.04	0.06	0.030	
16	341	3.2	3.5	5	2	-7	55	0.1	-0.01	0.8	0.3	1.5	1.9	2.5	1.3	1.1	0.000		0.04	0.04	0.08	0.010	
17	341	2.8	2.9	5	-1	-7	61	0.0	0.00	0.8	0.5	1.6	2.0	2.5	1.4	1.1	0.000		0.05	0.04	0.09	0.000	
18	336	1.8	1.9	6	-1	-7	64	0.0	0.00	0.8	0.5	1.5	2.0	2.6	1.4	1.1	0.000		0.06	0.04	0.09	0.000	
19	315	0.6	1.1	14	-2	-8	67	0.0	0.00	1.0	0.8	1.8	2.2	2.8	1.6	1.2	0.000		0.06	0.05	0.11	0.000	
20	200	0.7	0.9	6	-3	-8	72	0.0	0.00	1.4	2.3	3.8	3.1	3.5	1.9	1.6	0.000		0.07	0.17	0.24	0.001	
21	115	0.2	0.4	12	-4	-8	75	0.0	0.00	1.6	4.1	5.1	4.1	4.8	2.6	2.1	0.000		0.08	0.23	0.31	0.005	
22	171	1.0	1.0	10	-5	-9	77	0.0	0.00	3.5	6.9	9.3	5.1	5.6	3.0	2.6	0.000		0.08	0.36	0.44	0.016	
23	190	1.7	1.7	4	-4	-8	77	0.0	0.00	3.9	5.8	6.9	3.8	4.1	2.0	2.1	0.000		0.08	0.26	0.34	0.007	

DENVER, COLO.
NOV 23,1973

HOUR	VWDR	VWSP	WSPR	WSIG	TEMP	DWPT	RH	RAIN	UV	NEPH	CO	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	178	1.8	1.8	4	-5	-9	75	0.0	0.00	2.2	2.6	3.1	2.9	3.2	1.7	1.4	0.000		0.07	0.14	0.22	0.000	
01	206	1.3	1.5	4	-6	-9	76	0.0	0.00	1.9	1.7	1.9	2.6	2.9	1.7	1.2	0.000		0.07	0.12	0.19	0.000	
02	242	1.3	1.5	6	-6	-10	77	0.0	0.00	1.7	1.0	1.1	2.8	3.1	1.9	1.1	0.001		0.07	0.13	0.20	0.000	
03	182	1.3	1.5	4	-6	-10	77	0.0	0.00	1.8	1.3	3.7	2.9	3.2	2.0	1.2	0.000		0.07	0.13	0.20	0.000	
04	203	1.1	1.2	4	-7	-10	79	0.0	0.00	1.6	1.1	3.1	2.8	3.0	1.9	1.1	0.000		0.07	0.11	0.17	0.000	
05	226	0.9	1.4	8	-7	-10	79	0.0	0.00	2.6	1.7	3.7	3.4	3.7	2.3	1.3	0.002		0.08	0.23	0.31	0.005	
06	207	0.9	1.3	8	-7	-10	80	0.0	-0.00	1.9	2.9	4.8	3.7	3.9	2.2	1.7	0.000		0.08	0.27	0.35	0.009	
07	195	0.2	1.2	14	-6	-9	79	0.0	0.02	2.5	5.7	8.9	6.0	6.3	4.0	2.4	0.001		0.08	0.46	0.54	0.025	
08	180	1.1	1.2	9	-2	-7	69	0.0	0.36	2.7	7.3	8.6	5.2	5.2	2.4	2.8	0.001		0.11	0.36	0.48	0.021	
09	119	0.9	1.2	20	2	-6	57	-0.1	0.80	2.6	4.2	5.3	3.7	4.2	2.0	2.2	0.003		0.13	0.16	0.29	0.010	
10	187	1.1	1.4	13	4	-6	48	-0.3	1.16	1.9	2.2	3.2	2.8	3.0	1.5	1.5	0.003		0.10	0.07	0.17	0.020	
11	125	0.8	1.1	19	8	-6	37	-0.1	1.26	1.8	2.6	3.3		3.1	1.5	1.6	0.007		0.12	0.07	0.19	0.021	
12	64	1.8	1.9	15	7	-7	36	0.0	1.24	1.1	1.0	1.3	2.3	2.6	1.5	1.2	0.006		0.07	0.04	0.12	0.027	
13	71	2.2	2.3	10	8	-8	34	0.0	1.02	1.1	0.6	0.9	2.1	2.3	1.4	0.9	0.001		0.05	0.04	0.09	0.024	
14	50	1.6	2.0	10	8	-9	31	-0.1	0.59	1.4	1.3	1.0	2.2	2.5	1.4	1.2	0.009		0.06	0.03	0.10	0.032	
15	91	1.9	2.2	14	6	-9	34	-0.1	0.72	1.1	1.5	1.9	2.4	2.6	1.4	1.2	0.001		0.07	0.04	0.10	0.011	
16	118	2.0	2.2	5	4	-7	44	-0.1	-0.02	0.8	1.5	3.1	2.7	3.1	1.7	1.4	0.000		0.07	0.07	0.14	0.000	
17	179	1.7	1.9	6	2	-8	50	0.0	-0.00	0.8	3.0	4.4	2.6	2.9	1.4	1.5	0.000		0.08	0.09	0.18		
18	201	1.4	1.5	5	-0	-9	54	0.0	-0.00	0.9	3.1	4.7	2.7	3.0	1.4	1.6	0.000		0.08	0.15	0.23		
19	196	2.0	2.0	3	-0	-8	56	0.2	-0.00	1.0	3.0	4.6	2.9	3.2	1.4	1.8	0.000		0.09	0.15	0.23	0.003	
20	50	0.4	1.1	19	-2	-8	62	0.1	-0.00	1.3	4.1	6.2	4.6	4.7	2.3	2.4	0.000		0.09	0.21	0.30	0.004	
21	171	1.2	1.5	12	-3	-8	68	0.0	-0.00	1.8	6.9	9.0	4.9	5.4	2.5	2.9	0.000		0.09	0.34	0.42	0.013	
22	197	1.6	1.8	7	-3	-8	69	0.0	-0.00	2.0	5.7	8.0	4.0	4.3	1.9	2.3	0.000		0.08	0.30	0.39	0.012	
23	198	2.2	2.4	4	-4	-9	65	0.0	-0.00	1.5	4.5	5.1	3.4	3.9	1.8	2.0	0.000		0.08	0.18	0.26	0.002	

DENVER, COLO.
NOV 24,1973

HOUR	VWDR	VWSP	WSPD	WSTG	TEMP	DWPT	RH	RAIN	UV	NEPH	CO	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	206	2.0	2.1	4	-4	-11	60	0.0	0.00	1.1	2.1	2.9	2.9	3.3	1.8	1.5	0.000		0.08	0.11	0.18	0.000	
01	207	3.1	3.1	4	-3	-12	50	0.0	0.00	0.7	1.0	1.3	2.4	2.8	1.7	1.1	0.001		0.07	0.07	0.14	0.000	
02	210	3.0	3.1	5	-3	-13	47	0.0	0.00	0.5	0.4	0.8	2.2	2.5	1.6	0.9	0.000		0.06	0.03	0.08	0.001	
03	216	2.6	2.8	6	-3	-13	48	0.0	0.00	0.6	0.4	0.4	2.2	2.6	1.6	1.0	0.000		0.07	0.06	0.13	0.000	
04	212	2.0	2.6	9	-3	-13	48	0.0	0.01	0.6	0.3	0.4	2.6	2.9	2.0	0.9	0.001		0.07	0.05	0.11	0.000	
05	212	1.8	2.1	16	-4	-12	53	0.0	0.00	0.6	0.4	0.7	2.3	2.6	1.5	1.1	0.000		0.07	0.07	0.14	0.000	
06	197	2.3	2.4	3	-3	-13	49	0.0	0.00	0.6	0.6	1.1	2.1	2.4	1.5	1.0	0.004		0.07	0.06	0.13	0.000	
07	265	0.6	1.2	11	-3	-12	52	-0.1	0.03	0.8	1.7	2.4	3.3	3.9	2.1	1.8	0.007		0.08	0.18	0.25	0.001	
08	73	0.6	0.9	19	2	-10	43	-0.1	0.39	1.0	2.4	3.5	3.1	3.3	1.8	1.6	0.002		0.10	0.17	0.26	0.003	
09	90	0.7	1.1	23	4	-10	36	-0.5	0.82	0.9	2.2	3.6	3.1	3.3	1.8	1.4	0.002		0.10	0.10	0.20	0.006	
10	356	2.0	2.1	9	6	-9	32	0.3	1.15	1.2	1.3	2.5		3.6	1.5	2.1	0.003		0.10	0.04	0.14	0.026	
11	350	2.2	2.4	8	7	-10	31	0.1	1.19	1.4	1.5	2.7	2.7	2.9	1.5	1.4	0.006		0.11	0.05	0.16	0.023	
12	17	3.4	3.4	6	6	-9	35	0.0	1.22	1.3	0.5	1.9	2.2	2.5	1.3	1.2	0.001		0.04	0.02	0.07	0.032	
13	56	2.7	2.8	9	4	-9	40	0.0	0.81	1.3	0.3	2.0	2.5	2.8	1.5	1.3	0.000		0.04	0.02	0.06	0.033	
14	69	1.3	1.5	24	4	-9	40	0.0	0.44	0.8	0.2	2.4	2.1	2.5	1.4	1.1	0.000		0.03	0.02	0.05	0.035	
15	83	2.3	2.4	9	3	-9	41	0.0	0.14	0.6	0.2	2.3	2.0	2.4	1.4	0.9	0.000		0.04	0.02	0.06	0.020	
16	121	2.3	2.5	11	2	-9	44	0.0	-0.02	0.5	0.2	2.3	2.0	2.3	1.1	1.2	0.000		0.04	0.02	0.06	0.018	
17	139	3.1	3.1	4	2	-9	45	0.0	-0.00	0.6	0.7	2.2	2.0	2.3	1.2	1.1	0.000		0.05	0.02	0.07	0.012	
18	139	2.2	2.2	6	1	-9	47	0.0	0.00	0.6	0.8	2.5	2.0	2.4	1.3	1.2	0.000		0.06	0.02	0.08	0.006	
19	160	2.4	2.5	4	1	-9	49	0.0	0.00	0.7	1.1	2.8	2.1	2.4	1.3	1.2	0.000		0.06	0.03	0.09	0.002	
20	182	2.0	2.1	5	0	-9	52	0.0	0.00	0.9	1.4	3.3	2.2	2.6	1.3	1.3	0.000		0.07	0.04	0.12	0.000	
21	148	1.1	1.3	6	-0	-8	56	0.0	0.00	1.8	2.2	5.1	3.0	3.2	1.6	1.6	0.000		0.09	0.10	0.19	0.000	
22	127	1.4	1.7	5	-2	-8	61	0.1	0.00	1.4	2.0	3.5	3.6	4.0	2.6	1.5	0.000		0.08	0.08	0.16	0.000	
23	165	2.0	2.0	4	-2	-8	63	0.1	0.00	1.2	2.2	2.8	2.3	2.7	1.4	1.3	0.000		0.07	0.05	0.12	0.000	

DENVER, COLO.
NOV 25,1973

HOUR	VWDR	VWSP	WSPD	WSIG	TEMP	DWPT	RH	RAIN	LV	NEPH	CC	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	197	1.7	1.8	4	-3	-9	65	-0.1	0.00	1.4	1.7	2.4	2.6	3.0	1.6	1.4	0.000		0.07	0.08	0.16	0.000	
01	209	1.4	1.7	6	-4	-10	67	0.0	0.00	2.0	2.0	3.1	3.0	3.3	1.8	1.6	0.000		0.08	0.13	0.21	0.000	
02	186	2.1	2.1	3	-5	-9	70	0.0	0.00	1.8	1.9	2.3	3.0	3.4	1.9	1.6	0.000		0.08	0.09	0.17	0.000	
03	193	2.7	2.8	3	-5	-10	68	0.1	0.00	1.5	1.1	1.1	2.5	2.9	1.6	1.3	0.000		0.07	0.06	0.13	0.000	
04	207	2.1	2.1	4	-4	-10	64	0.0	0.01	1.5	0.7	0.4	2.6	3.0	1.8	1.2	0.008		0.08	0.09	0.17	0.000	
05	243	1.0	1.2	6	-5	-11	67	0.0	0.00	1.6	0.9	0.9	3.0	3.3	2.0	1.3	0.000		0.07	0.08	0.15	0.000	
06	273	0.5	1.0	6	-6	-11	71	0.0	0.00	1.8	1.2	0.6	3.2	3.8	2.2	1.6	0.000		0.08	0.11	0.19	0.000	
07	234	0.5	1.0	6	-6	-10	73	0.0	0.01	1.9	1.8	1.7	4.6	4.6	3.0	1.6	0.000		0.08	0.15	0.23	0.000	
08	242	0.6	1.1	8	-3	-9	66	0.0	0.32	1.6	1.5	1.1	4.3	4.7	3.3	1.4	0.001		0.08	0.10	0.18	0.001	
09	168	0.5	0.9	20	2	-6	56	-0.1	0.75	1.7	1.1	1.6	2.9	3.3	1.7	1.6	0.004		0.08	0.07	0.15	0.006	
10	351	0.2	0.6	35	6	-6	41	-0.3	1.07	1.8	0.9	1.8	2.7	3.2	1.6	1.6	0.017		0.10	0.10	0.19	0.008	
11	342	0.9	1.3	16	7	-8	35	0.0	1.22	1.9	0.8	1.3	2.9	3.2	1.5	1.6	0.018		0.11	0.06	0.17	0.021	
12	30	2.2	2.4	13	6	-6	42	-0.1	1.14	1.9	0.7			3.7	1.5	2.1	0.037		0.12	0.09	0.21	0.022	
13	6	3.1	3.4	8	5	-7	43	0.0	0.59	1.5	0.3	0.8	2.1	2.5	1.2	1.2	0.028		0.09	0.07	0.16	0.007	
14	54	1.9	2.1	9	4	-6	49	0.2	0.48	1.2	0.2	0.7	2.6	3.0	1.4	1.5	0.012		0.05	0.03	0.08	0.021	
15	57	1.8	1.9	9	4	-6	49	0.0	0.22	1.2	0.2	0.7	2.8	3.1	1.5	1.6	0.010		0.05	0.03	0.08	0.020	
16	90	1.3	1.4	6	1	-7	55	0.0	-0.02	1.4	0.4	1.2	3.5	3.8	2.4	1.4	0.000		0.07	0.03	0.10	0.011	
17	69	0.4	0.7	13	-0	-7	62	0.0	-0.00	1.6	1.1	1.9	4.0	4.3	2.6	1.7	0.000		0.10	0.05	0.15	0.000	
18	162	1.5	1.6	10	0	-7	62	0.0	0.00	1.9	3.6	6.9	4.2	4.4	2.1	2.4	0.000		0.11	0.18	0.29	0.003	
19	177	2.1	2.2	3	-0	-7	63	0.0	0.00	2.5	4.3	6.6	3.8	4.1	1.6	2.5	0.000		0.10	0.17	0.27	0.001	
20	209	0.7	1.1	13	-2	-7	68	-0.1	0.00	3.2	5.2	8.0	4.3	4.5	1.9	2.6	0.000		0.11	0.29	0.40	0.011	
21	142	0.5	1.4	8	-2	-7	70	0.0	0.00	3.4	6.0	9.1	4.8	4.8	2.0	2.9	0.000		0.10	0.31	0.41	0.012	
22	207	0.7	1.1	8	-2	-7	72	0.0	0.00	3.4	4.7	8.1	4.4	4.6	2.0	2.6	0.000		0.09	0.27	0.37	0.010	
23	180	1.4	1.5	7	-3	-7	74	0.0	0.00	4.0	7.1	10.2	4.8	5.2	2.3	2.9	0.000		0.10	0.33	0.44	0.016	

DENVER, COLO.
NOV 26,1973

HOUR	VWDR	VWSP	WSPD	WSIG	TEMP	DWPT	RH	RAIN	UV	NEPH	CO	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	213	1.9	2.1	5	-3	-7	74	0.1	-0.00	3.7	5.3	7.0	4.3	4.5	2.0	2.5	0.000		0.10	0.25	0.35	0.010	
01	182	1.4	1.8	11	-3	-8	72	-0.1	-0.00	2.7	2.3	3.0	3.2	3.6	1.8	1.8	0.000		0.10	0.13	0.22	0.002	
02	111	0.8	1.1	11	-4	-9	72	0.1	-0.00	2.8	2.9	4.3	4.1	4.2	2.2	2.0	0.000		0.09	0.15	0.23	0.001	
03	168	0.5	1.6	5	-5	-9	73	-0.1	-0.00	2.5	2.0	3.4	3.7	3.9	2.1	1.9	0.000		0.08	0.14	0.21	0.001	
04	237	0.8	0.9	7	-6	-9	78	0.1	0.00	3.2	2.7	3.1	5.7	6.2	3.9	2.3	0.000		0.08	0.21	0.29	0.006	
05	328	0.4	0.9	6	-5	-9	79	0.0	0.00	2.3	0.8	0.4	6.2	6.9	4.4	2.5	0.001		0.06	0.07	0.13	0.000	
06	94	0.5	0.9	10	-6	-9	80	0.0	-0.00	2.5	2.3	2.7	4.6	5.3	2.8	2.5	0.000		0.06	0.17	0.23	0.003	
07	194	1.3	1.4	5	-5	-8	82	0.0	-0.03	2.7	8.0	10.0	6.1	6.5	2.8	3.7	0.000		0.09	0.40	0.49	0.021	
08	182	1.5	1.6	9	-3	-7	75	0.1	0.18	2.8	8.3	11.2	5.4	5.7	2.2	3.5	0.000		0.14	0.39	0.53	0.025	
09	192	1.6	1.7	7	-2	-10	56	0.0	0.48	1.8	5.6	6.7	3.6	3.8	1.5	2.3	0.000		0.13	0.19	0.32	0.010	
10	207	0.3	0.8	14	2	-8	49	-0.1	0.80	2.0	3.8	5.9	3.2	3.4	1.4	2.0	0.002		0.14	0.15	0.29	0.008	
11	68	0.9	1.4	15	3	-11	36	0.0	0.86	1.2	2.3	3.0	2.5	2.8	1.3	1.5	0.000		0.10	0.05	0.15	0.013	
12	25	3.7	3.9	5	2	-7	49	0.1	0.85	3.3	2.2	3.3	3.6	3.8	1.6	2.2	0.009		0.14	0.07	0.20	0.015	
13	22	4.4	4.5	5	2	-6	56	-0.1	0.69	2.9	0.8	1.3	3.1	3.4	1.6	1.9	0.005		0.07	0.04	0.11	0.014	
14	355	3.5	3.6	6	2	-6	57	-0.2	0.50	2.3	0.7	1.0	2.7	3.1	1.5	1.6	0.001		0.06	0.04	0.10	0.010	
15	336	3.7	3.8	6	2	-7	54	0.4	0.12	1.9	0.5	0.9	2.5	2.8	1.4	1.4	0.000		0.06	0.03	0.08	0.007	
16	330	3.4	3.4	7	0	-7	61	-0.2	-0.03	2.0		1.6	2.5				0.000		0.07	0.03	0.09	0.000	
17	329	3.4	3.4	7	-0	-6	63	0.1	-0.00	1.9	0.9	1.5	2.4	3.0	1.3	1.7	0.000		0.07	0.03	0.09	0.000	
18	327	3.2	3.2	6	-0	-7	63	0.0	-0.00	1.1	0.5	0.8	2.1	2.8	1.2	1.5	0.000		0.05	0.02	0.07	0.000	
19	343	2.6	2.6	6	-2	-6	75	0.0	0.00	0.9	0.4	0.5	2.0	2.7	1.2	1.5	0.000		0.04	0.02	0.06	0.000	
20	340	1.7	1.7	7	-2	-5	83	0.1	0.00	0.7	0.3	0.8	2.0	2.8	1.2	1.5	0.000		0.04	0.02	0.06	0.000	
21	311	1.5	1.7	8	-2	-5	83	0.0	0.00	0.7	0.3	1.5	2.4	3.0	1.4	1.6	0.000		0.04	0.02	0.06	0.000	
22	308	3.4	3.4	6	-2	-6	76	0.0	0.00	0.8	0.1	1.9	1.9	2.6	1.2	1.3	0.000		0.02	0.02	0.04	0.000	
23	318	3.7	3.8	6	-2	-6	78	-0.1	0.00	0.9	0.0	3.0	1.8	2.5	1.2	1.3	0.000		0.02	0.01	0.03	0.001	

DENVER, COLO.
NOV 27,1973

HOUR	VWDP	VWSP	WSPD	WSIG	TEMP	DWPT	RH	RAIN	UV	NFPH	CC	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	327	4.0	4.0	5	-2	-6	78	0.1	0.00	0.6	-0.0	3.1	1.8	2.4	1.1	1.2	0.000		0.02	0.01	0.03	0.005	
01	347	5.9	6.1	5	-3	-6	79	0.3	0.00	0.6	-0.0	3.1	1.7	2.3	1.1	1.1	0.000		0.02	0.05	0.08	0.008	
02	333	3.8	4.1	5	-3	-6	79	0.0	0.00	0.4	-0.0	2.9	1.6	2.1	1.1	1.0	0.000		0.01	0.01	0.03	0.016	
03	349	2.4	2.5	7	-4	-7	79	0.0	0.00	0.5	-0.0	2.9	1.7	2.1	1.2	1.0	0.000		0.01	0.01	0.03	0.013	
04	339	1.1	1.2	9	-5	-7	81	0.0	0.00	0.5	-0.0	2.9	1.7	2.2	1.2	1.0	0.000		0.02	0.01	0.03	0.010	
05	212	1.0	1.1	5	-6	-9	81	0.0	0.00	0.8	0.7	4.2	2.6	3.1	1.7	1.4	0.000		0.06	0.09	0.14	0.001	
06	192	1.7	1.7	3	-7	-9	83	0.0	0.00	1.0	3.1	5.7	3.3	3.7	1.6	2.1	0.000		0.08	0.20	0.28	0.006	
07	202	1.3	1.4	5	-6	-9	85	-0.1	0.01	1.3	5.2	7.2	3.8	4.3	1.6	2.7	0.000		0.08	0.25	0.34	0.010	
08	239	1.5	1.6	6	-2	-7	72	-0.2	0.44	1.8	7.1	9.0	4.2	4.5	1.6	2.9	0.003		0.12	0.30	0.42	0.020	
09	309	1.3	1.6	11	2	-7	52	3.2	0.97	1.1	2.9	2.4	2.8	3.2	1.5	1.7	0.001		0.09	0.07	0.15	0.016	
10	299	3.7	3.8	7	4	-12	32	0.1	1.40	0.5	0.3	-0.5	2.3	2.5	1.4	1.2	0.000		0.02	0.02	0.04	0.020	
11	298	4.6	4.8	8	4	-15	25	-0.1	1.55	0.4	0.2	-0.0	2.2	2.3	1.2	1.1						0.019	
12	294	5.2	5.4	6	4	-15	25	-0.2	1.48	0.3	0.1	0.1	2.3	2.7	1.6	1.1	0.000		0.02	0.01	0.03	0.020	
13	289	5.2	5.3	6	4	-16	24		1.21	0.3	0.0	0.4	2.5	2.7	1.5	1.2	0.000		0.01	0.01	0.03	0.020	
14	284	6.5	6.7	6	3	-15	25	0.1	0.78	0.3	0.1	1.3	2.1	2.2	1.2	1.0	0.000		0.02	0.02	0.04	0.016	
15	294	6.9	7.0	5	3	-14	28	-0.1	0.31	0.3	0.2	1.3	2.7	3.2	2.0	1.2	0.000		0.02	0.01	0.03	0.014	
16	297	7.9	7.9	5	1	-14	31	0.1	-0.01	0.3	0.3	0.6	2.6	2.9	1.8	1.1	0.000		0.03	0.01	0.04	0.012	
17	281	5.4	5.5	5	0	-14	34	0.1	-0.01	0.4	0.3	0.7	2.1	2.4	1.5	1.0	0.000		0.03	0.02	0.05	0.008	
18	290	5.4	5.5	5	0	-14	34	-0.4	0.00	0.3	0.3	0.5		2.6	1.3	1.3			0.03	0.01	0.04	0.011	
19	314	4.7	4.8	4	-0	-13	37	0.0	0.00	0.3		0.0							0.02	0.01	0.03	0.015	
20	300	2.2	2.3	12	-0	-13	39	-0.1	0.00	0.5		-0.4							0.03	0.01	0.03	0.015	
21	276	1.3	1.8	15	-1	-13	42	0.0	0.00	0.5		-0.1							0.03	0.01	0.04	0.010	
22	284	2.3	2.4	12	0	-13	38	0.0	0.00	0.4		-0.5							0.03	0.01	0.04	0.011	
23	292	3.8	3.9	8	1	-12	37	0.1	0.00	0.4		-0.6							0.02	0.01	0.02	0.017	

DENVER, COLO.
NOV 28,1973

HOUR	VWDR	VWSP	WSPD	WSIG	TEMP	DWPT	RH	RAIN	UV	NEPH	CC	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	297	3.5	3.6	6	2	-12	37	-0.1	0.00	0.4		-0.3							0.02	0.00	0.02	0.019	
01	295	4.6	4.7	4	3	-11	37	0.0	0.00	0.3		-0.1							0.02	0.00	0.02	0.017	
02	289	4.4	4.4	4	2	-11	39	0.0	0.00	0.4		-0.4							0.02	0.01	0.02	0.021	
03	276	1.9	2.3	8	1	-11	42	0.0	0.00	0.4		-0.1							0.03	0.01	0.04	0.009	
04	211	2.6	2.8	7	1	-10	43	0.0	0.00	0.4		-0.4							0.05	0.01	0.06	0.004	
05	177	2.7	2.8	5	-0	-11	45	0.0	0.00	0.5		0.3							0.06	0.04	0.10	0.000	
06	203	2.3	2.4	4	-0	-10	49	0.0	0.00	0.6		2.1							0.06	0.11	0.17	0.000	
07	199	2.7	2.8	4	2	-9	43	0.0	0.02	0.8		5.2							0.08	0.21	0.29	0.005	
08	259	3.9	4.1	7	7	-8	35	0.0	0.41	1.0		3.9							0.08	0.16	0.25	0.007	
09	271	4.4	4.5	5	11	-7	29	0.2	0.87	0.7		0.6							0.05	0.03	-0.03	0.008	
10	268	4.3	4.4	7	14	-6	25	-0.1	1.21	0.4		0.3							0.04	0.03	0.04	0.013	
11	274	3.8	3.9	8	15	-7	22	-0.2	1.36	0.4		0.5							0.03	0.02	0.05	0.018	
12	254	1.7	2.3	13	17	-7	19	0.0	1.27	0.5		1.4							0.04	0.03	0.06	0.019	
13	169	1.5	2.0	16	16	-10	16	-0.1	1.00	0.3		1.9							0.04	0.03	0.07	0.026	
14	313	2.9	3.2	10	18	-9	16	0.1	0.66	0.3		0.1							0.03	0.02	0.06	0.021	
15	296	2.9	3.0	5	16	-10	16	-0.1	0.25	0.4		0.0							0.05	0.03	0.07		
16	302	1.4	1.6	8	13	-10	19	0.4	-0.01	0.7		1.3							0.07	0.05	0.12	0.000	
17	249	1.4	1.5	13	9	-10	25	-0.1	0.01	0.8		2.1							0.07	0.04	0.10	0.000	
18	213	2.2	2.3	5	8	-10	28	-0.2	0.01	1.3		6.4							0.08	0.25	0.33	0.011	
19	274	0.9	1.7	9	7	-9	33	0.1	0.01	1.2		5.8							0.08	0.25	0.33	0.009	
20	197	1.2	1.4	12	5	-8	40	0.0	0.00	2.0		7.9							0.07	0.43	0.50	0.021	
21	169	1.1	1.5	8	5	-8	38	0.0	0.00	1.4		6.8							0.09	0.29	0.38	0.008	
22	195	1.8	2.2	5	5	-9	35	0.0	-0.00	0.9		6.0							0.08	0.24	0.33	0.005	
23	165	1.4	1.5	11	3	-9	42	0.0	-0.00	0.9		7.8							0.08	0.25	0.33	0.004	

DENVER, COLO.
NOV 29,1973

HOUR	VWDR	VWSP	WSPD	WSIG	TEMP	DWPT	RH	RAIN	UV	NEPH	CO	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	151	1.4	1.6	15	3	-9	42	0.0	-0.00	0.7		5.3							0.07	0.15	0.22	0.000	
01	187	2.4	2.6	8	2	-10	42	0.0	-0.00	0.4		3.4							0.07	0.08	0.15	0.000	
02	212	1.6	2.0	20	2	-9	45	0.0	-0.00	0.8		3.9							0.09	0.19	0.27	0.001	
03	204	1.3	1.6	18	1	-9	48	0.0	-0.00	0.8		3.4							0.08	0.20	0.28	0.001	
04	193	0.9	1.4	15	1	-8	51	0.0	-0.00	0.8		3.4							0.09	0.20	0.29	0.003	
05	194	1.2	1.7	14	2	-9	47	0.0	-0.00	0.6		3.3							0.08	0.18	0.26	0.002	
06	229	1.0	1.5	21	1	-8	50	0.0	-0.00	1.2		6.1							0.09	0.41	0.50	0.013	
07	243	1.6	1.9	13	3	-8	45	0.1	-0.01	1.4		9.5							0.06	0.57	0.63	0.022	
08	227	1.9	2.5	10	5	-8	38	-0.1	0.15	2.1		12.4							0.11	0.60	0.72	0.025	
09	236	1.4	1.7	14	8	-8	33	-0.1	0.58	1.7		9.6							0.12	0.43	0.55	0.014	
10	313	0.5	1.3	17	13	-6	25	-0.1	0.58	1.7		9.5							0.18	0.20	0.37	0.015	
11	30	1.6	1.9	12	15	-6	25	-0.1	0.97	1.9		8.8							0.21	0.12	0.33	0.017	
12	35	2.0	2.1	8	13	-3	33	0.1	0.85	1.6		4.7										0.010	
13	56	1.0	1.3	22	14	-2	34	0.0	0.93	1.7		4.7							0.11	0.06	0.17	0.014	
14	21	1.5	1.6	10	16	-3	28	-0.1	0.61	2.1		4.7							0.13	0.06	0.19	0.018	
15	47	0.7	1.0	12	14	-2	34	0.0	0.17	2.6		5.6							0.15	0.08	0.22	0.012	
16	48	1.2	1.3	7	11	-2	42	0.1	-0.01	2.4		6.1							0.11	0.19	0.29	0.008	
17	53	0.2	0.7	21	7	-2	54	0.0	0.01	2.7		10.1							0.09	0.27	0.36	0.014	
18	167	1.0	1.1	5	5	-2	59	0.0	0.02	3.3		13.5							0.09	0.52	0.61	0.040	
19	268	0.1	0.9	16	4	-3	60	0.2	0.01	3.8		16.1							0.06	0.56	0.62	0.043	
20	209	0.1	0.7	20	2	-3	68	0.1	0.02	4.9		17.4							0.12	0.77	0.89	0.061	
21	220	0.7	1.0	19	2	-3	73	0.0	0.00	5.9		22.6							0.15	1.09	1.24	0.084	
22	211	1.3	1.9	15	2	-2	72	0.0	0.00	6.7		28.2							0.21	1.27	1.48	0.104	
23	257	0.4	1.3	21	2	-3	71	0.0	0.00	5.9		23.5							0.18	1.08	1.26	0.087	

DENVER, COLO.
NOV 30,1973

HOUR	VWDR	VWSP	WSPD	WSIC	TEMP	DWPT	RH	RAIN	UV	NEPH	CC	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	208	1.1	1.6	11	1	-4	70	0.0	0.00	5.0		16.8							0.15	0.87	1.02	0.072	
01	154	0.4	0.7	21	0	-5	70	0.0	0.00	4.8		16.3							0.15	0.82	0.97	0.066	
02	219	0.7	0.8	9	-0	-4	75	0.0	0.00	5.1		15.8							0.16	0.94	1.10	0.078	
03	284	0.4	0.9	19	-1	-5	75	0.0	-0.00	4.4		15.0							0.13	0.87	1.00	0.067	
04	124	0.3	0.8	17	-1	-5	75	0.0	-0.00	3.7		13.7							0.13	0.79	0.93	0.060	
05	242	0.5	0.7	10	-2	-5	77	0.0	-0.00	4.3		15.4							0.14	0.93	1.07	0.070	
06	193	1.0	1.2	7	-2	-5	76	0.0	0.00	4.2		18.2							0.16	1.09	1.25	0.085	
07	176	1.0	1.3	12	-0	-5	72	0.0	-0.01	3.1		20.3							0.13	0.94	1.07	0.067	
08	194	1.2	1.9	22	1	-5	64	-0.2	0.23	3.3		21.4							0.17	0.98	1.15	0.073	
09	180	0.8	1.0	18	6	-3	54	0.0	0.62	4.4		19.5							0.25	0.85	1.10	0.075	
10	358	0.6	1.0	11	10	-6	33	0.0	0.82	2.6		8.1							0.21	0.20	0.41	0.023	
11	344	1.0	1.2	10	11	-6	29	0.1	0.93	3.0		2.6							0.18	0.10	0.28	0.018	
12	34	1.0	1.3	11	13	-7	24	-0.1	0.85	2.3		2.2	3.7				0.013	0.14	0.15	0.04	0.19	0.021	
13	28	2.5	2.6	6	11	-5	31	0.0	0.73	3.1		2.0	3.2				0.021	0.20	0.15	0.07	0.22	0.019	
14	15	2.5	2.6	6	11	-3	38	-0.1	0.54	1.7		1.5	3.3				0.011	0.09	0.07	0.03	0.10	0.016	
15	16	2.7	3.0	6	10	-3	42	0.0	0.20	1.8		2.3	3.1				0.002	0.07	0.07	0.03	0.09	0.016	
16	44	2.3	2.3	5	7	-3	52	0.0	-0.01	2.5		2.1	3.9				0.000	0.07	0.08	0.03	0.11	0.009	
17	24	1.7	1.7	5	4	-3	60	0.0	0.01	2.6		5.0	4.1				0.000	0.11	0.10	0.10	0.20	0.002	
18	68	0.8	1.0	14	2	-4	66	0.3	0.01	2.2	1.9	1.6	4.0	6.3	1.8	4.5	0.000	0.10	0.09	0.05	0.14	0.000	
19	339	0.8	0.5	14	1	-4	69	0.0	0.01	2.1	1.5	1.8	3.8	5.6	1.7	3.9	0.000	0.10	0.09	0.08	0.16	0.000	
20	337	0.7	0.7	9	1	-4	72	0.0	0.01	2.0	1.7	2.6	3.4	4.9	1.7	3.3	0.000	0.08	0.09	0.14	0.23	0.003	
21	32	0.8	1.2	9	1	-4	71	0.0	0.00	2.1	2.4	4.1	4.8	5.6	1.9	3.7	0.001	0.07	0.09	0.16	0.26	0.004	
22	118	0.7	0.7	9	0	-4	74	0.0	0.00	2.0	2.4	4.2	4.6	5.4	2.3	3.1	0.001	0.06	0.09	0.17	0.26	0.004	
23	125	0.5	0.7	14	-0	-4	77	0.0	0.00	2.1	3.6	5.3	5.2	5.8	2.5	3.3	0.002	0.05	0.09	0.27	0.36	0.012	

DENVER, COLO.
DEC 1,1973

HOUR	VWDR	VWSP	WSPD	WSIG	TEMP	DWPT	RH	RAIN	UV	NEPH	CC	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	140	0.4	0.7	18	-0	-4	77	0.0	0.00	2.3	3.3	6.2	5.5	5.9	2.5	3.4	0.001	0.05	0.09	0.25	0.33	0.010	
01	11	0.6	0.8	14	-1	-4	78	0.0	0.00	2.5	3.1	5.4	5.8	6.4	2.7	3.7	0.004	0.04	0.08	0.25	0.33	0.009	
02	354	0.5	0.6	9	-1	-4	82	0.0	0.00	2.6	2.1	4.3	5.5	5.8	2.2	3.5	0.008	0.02	0.08	0.22	0.30	0.006	
03	320	0.5	0.6	6	-2	-4	84	0.0	0.00	2.8	2.4	5.1	7.4	6.5	4.3	3.0	0.008	0.03	0.08	0.26	0.34	0.009	
04	97	0.5	0.6	12	-2	-4	81	0.0	-0.00	3.1	3.4	6.1	8.6	8.1	3.7	4.4	0.004	0.04	0.08	0.32	0.41	0.015	
05	204	0.8	0.9	8	-2	-5	84	0.0	-0.00	3.5	4.2	7.1	8.9	9.2	4.4	4.8	0.006	0.04	0.09	0.40	0.49	0.021	
06	205	1.2	1.3	8	-3	-5	86	0.0	-0.00	4.4	6.0	11.2	9.2	9.1	4.1	5.0	0.004		0.12	0.69	0.82	0.047	
07	237	1.1	1.5	7	-2	-5	85	-0.1	-0.00	4.9	8.2	14.1	9.4	9.1	3.5	5.6	0.003		0.14	0.76	0.91	0.053	
08	263	1.1	1.4	5	-2	-4	83	-0.1	0.23	5.0	9.1	13.9	9.7	8.2	3.2	5.0	0.004		0.15	0.69	0.84	0.055	
09	197	1.7	2.4	16	6	-2	62	0.1	0.70	4.4	8.4	10.6	10.7	12.4	6.5	4.9	0.008	0.22	0.19	0.46	0.65	0.047	
10	200	3.0	3.0	5	15	-7	22	-0.2	1.08	0.7	1.4	2.8	2.4	3.1	1.2	1.9	0.000	0.09	0.07	0.04	0.11	0.010	
11	196	3.5	3.5	5	19	-9	15	0.1	1.22	0.6	1.0			2.7	1.1	1.7	0.000	0.05	0.05	0.02	0.07		
12	204	3.5	3.6	6	20	-8	15	-0.1	1.18	0.5	0.7		2.1	2.5	1.0	1.5	0.002	0.05	0.05	0.04	0.09		
13	208	2.4	2.6	8	21	-8	14	0.0	0.97	0.4	0.5		2.0	2.4	1.0	1.4	0.002	0.04	0.04	0.03	0.06		
14	342	1.2	3.0	8	21	-5	19	0.0	0.57	2.6	1.3		3.2	3.6	1.5	2.2	0.000	0.05	0.08	0.02	0.10	0.053	0.054
15	28	3.2	3.3	3	16	2	39	-0.1	0.20	7.6	2.4		7.0	7.5	2.8	4.7	0.000	0.13	0.16	0.01	0.17	0.097	0.038
16	49	1.7	1.8	6	11	1	51	0.0	-0.02	8.0	2.5		8.5	9.2	3.5	5.7	0.004	0.16	0.17	0.01	0.19	0.050	0.043
17	55	0.6	0.8	12	7	0	64	0.0	0.00	7.7	3.3		7.4	8.1	3.3	4.8	0.000	0.16	0.16	0.02	0.18	0.019	0.015
18	188	1.0	1.1	13	5	0	70	0.0	0.01	8.1	4.2		7.8	8.9	3.7	5.1	0.000	0.16	0.17	0.12	0.29	0.017	0.003
19	199	1.9	2.0	6	6	1	70	0.0	0.01	9.5	11.1		9.6	10.1	3.4	6.7	0.000	0.21	0.22	0.32	0.55	0.035	-0.001
20	227	1.1	1.9	6	5	-0	69	0.0	0.01	11.2	11.7		11.5	10.3	4.9	6.8	0.004	0.24	0.15	0.45	0.61	0.050	-0.001
21	339	0.4	1.3	7	3	-1	76	0.3	0.01	9.9	11.2		11.6	11.8	5.5	6.4	0.004	0.22	0.13	0.47	0.61	0.048	-0.001
22	231	1.9	2.3	6	5	-2	62	0.1	0.01	3.2	4.5		6.2	6.1	2.7	3.4	0.003	0.11	0.09	0.22	0.32	0.014	-0.001
23	236	2.1	2.9	7	7	-7	36	-0.1	0.00	0.8	1.2		4.5	4.7	2.8	1.9	0.004	0.05	0.06	0.10	0.15	0.000	-0.001

DENVER, COLO.
DEC 2,1973

HOUR	VWDR	VWSP	WSPD	WSIG	TEMP	DWPT	RH	RAIN	UV	NEPH	CC	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	200	5.4	5.4	3	10	-8	28	0.0	-0.00	0.4	0.3		1.8	2.3	1.0	1.3	0.000	0.02	0.04	0.04	0.07	0.000	0.003
01	189	4.6	4.7	3	10	-8	27	0.0	-0.00	0.3	0.2		1.8	2.3	1.0	1.3	0.002	0.04	0.05	0.06	0.11	0.000	0.000
02	182	4.0	4.0	4	10	-8	29	0.0	-0.01	0.4	0.3		1.9	2.3	1.0	1.3	0.007	0.04	0.05	0.08	0.13	0.000	-0.001
03	193	4.7	4.8	4	10	-8	28	0.1	-0.01	0.4	0.1		1.8	2.2	0.9	1.3	0.010	0.03	0.05	0.06	0.11	0.000	0.000
04	197	2.8	3.5	20	9	-8	30	-0.1	-0.01	0.4	0.1		1.7	2.2	0.9	1.3	0.003	0.01	0.03	0.04	0.07	0.000	0.007
05	185	6.6	6.7	5	11	-8	27	0.1	-0.01	0.3	0.1		1.6	2.1	0.8	1.2	0.000	-0.01	0.02	0.04	0.06	0.002	0.011
06	191	5.8	5.9	5	11	-7	27	0.1	-0.01	0.3	0.1		1.6	2.1	0.8	1.2	0.000	-0.01	0.02	0.04	0.06	0.001	0.010
07	184	6.1	6.1	4	11	-7	29	0.0	0.01	0.3	0.1		1.6	2.1	0.8	1.3	0.000	-0.01	0.02	0.04	0.07	0.000	0.009
08	183	6.0	6.0	3	12	-7	26	-0.2	0.37	0.3	0.2		1.7	2.2	0.9	1.3	0.000	-0.01	0.02	0.05	0.07	0.001	0.010
09	187	5.4	5.5	4	14	-7	23	0.0	0.81	0.4	0.3		1.7	2.3	0.9	1.3	0.000	-0.01	0.02	0.03	0.05	0.005	0.013
10	191	4.6	4.7	7	16	-6	21	0.0	1.15	0.5	0.2		1.7	2.2	0.9	1.3	0.000	-0.02	0.01	0.01	0.03	0.009	0.017
11	8	2.6	4.0	11	16	-5	24	0.0	1.26	1.0	0.3		2.1	2.7	1.1	1.6	0.000	-0.00	0.04	0.03	0.06	0.010	0.016
12	349	4.7	4.9	6	14	-5	27	0.1	1.09	1.2	0.3		1.8	2.5	1.0	1.4	0.001	0.01	0.03	0.05	0.08	0.015	0.017
13	16	6.8	6.9	4	13	-5	29	0.0	0.72	0.7	0.2		1.9	2.5	1.0	1.4	0.000	-0.02	0.01	0.00	0.02	0.017	0.023
14	351	6.3	6.4	5	11	-4	37	0.0	0.32	0.9	0.2		1.7	2.3	1.0	1.3	0.011	-0.00	0.04	0.14	0.18	0.008	0.003
15	9	7.0	7.0	5	9	-3	43	0.1	0.05	0.6	0.1		1.7	2.3	1.0	1.3	0.005	-0.02	0.01	0.03	0.04	0.007	0.013
16	20	8.2	8.3	3	7	-4	49	-0.1	-0.03	0.6	0.1		1.8	2.5	1.0	1.4	0.000	-0.04	0.01	0.00	0.01	0.007	0.015
17	21	7.7	7.8	5	4	-4	57	0.1	-0.01	0.6	0.1		1.8	2.5	1.1	1.4	0.001	-0.04	0.01	-0.00	0.01	0.008	0.017
18	13	7.6	7.7	4	1	-3	76	0.0	0.00	0.6	0.1		1.7	2.5	1.1	1.4	0.000	-0.04	0.01	0.00	0.01	0.002	0.012
19	11	5.1	5.1	4	-0	-3	84	0.0	0.00	0.6	0.1		1.7	2.5	1.1	1.3	0.000	-0.04	0.01	0.00	0.01	0.002	0.012
20	8	5.6	5.7	5	-0	-3	84	0.1	0.00	0.5	0.1		1.6	2.4	1.1	1.3	0.000	-0.03	0.01	0.00	0.01	0.005	0.015
21	15	5.3	5.3	4	-1	-3	88	0.0	-0.00	0.4	0.1		1.7	2.4	1.1	1.3	0.000	-0.01	0.01	0.01	0.02	0.008	0.017
22	20	5.4	5.5	4	-1	-3	89	0.0	-0.01	0.4	0.1		1.7	2.5	1.1	1.4	0.000	0.00	0.01	0.01	0.02	0.011	0.019
23	16	4.5	4.5	4	-1	-3	89	0.2	-0.01	0.4	0.1		1.9	2.5	1.1	1.3	0.000	0.00	0.01	0.02	0.03	0.012	0.019

DENVER, COLO.
DEC 3,1973

HOUR	VWDR	VWSP	WSPD	WSTG	TEMP	DWPT	RH	RAIN	UV	NFPH	CC	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	12	5.5	5.5	4	-1	-3	87	-0.2	-0.01	0.4	0.1		1.6	2.3	1.0	1.2	0.000	0.00	0.01	0.02	0.03	0.014	0.020
01	7	5.7	5.7	4	-2	-4	86	0.0	-0.01	0.4	0.1		1.6	2.2	1.0	1.2	0.000	0.00	0.01	0.02	0.03	0.013	0.020
02	359	3.0	3.1	5	-2	-4	88		-0.01	0.3	0.1		1.7	2.2	1.0	1.3	0.000	-0.00	0.02	0.02	0.04	0.012	0.018
03	359	3.1	3.2	5	-2	-4	86		-0.01	0.3	0.1		1.7	2.2	1.0	1.2	0.000	-0.00	0.02	0.02	0.04	0.012	0.018
04	346	0.9	1.8	11	-2	-4	87	0.0	-0.01	0.4	0.1		2.2	2.6	1.1	1.5	0.001	0.00	0.02	0.03	0.05	0.008	0.014
05	263	0.8	1.1	17	-2	-4	86	0.0	-0.01	0.4	0.2		2.1	2.5	1.1	1.4	0.000	0.03	0.05	0.03	0.08	0.000	0.005
06	330	0.4	1.0	17	-2	-5	85	0.0	-0.01	0.5	0.6		2.4	2.8	1.3	1.5	0.000	0.04	0.06	0.06	0.12	0.001	0.002
07	122	0.4	0.8	16	-3	-5	85	0.0	-0.01	0.6	2.1		3.1	3.7	1.3	2.4	0.001	0.04	0.05	0.10	0.15	0.003	0.004
08	189	1.8	1.8	4	-2	-5	83	0.1	0.34	0.9	3.2		3.8	4.3	1.2	3.1	0.000	0.08	0.09	0.19	0.29	0.010	0.001
09	165	3.1	3.1	4	-0	-4	73	0.4	0.90	1.0	2.8		3.3	3.9	1.2	2.7	0.002	0.09	0.10	0.12	0.23	0.012	0.007
10	154	2.5	2.6	6	1	-4	66	2.1	1.36	0.6	1.3		2.4	2.9	1.0	1.9	0.000	0.06	0.07	0.08	0.15	0.014	0.014
11	141	1.0	1.3	13	4	-5	53	0.0	1.53	0.6	1.0		2.5	2.8	1.0	1.8	0.001	0.05	0.08	0.08	0.15	0.016	0.016
12	276	0.5	0.7	12	8	-4	45	0.5	1.47	0.7	0.9		2.2	2.9	1.0	1.9	0.006	0.06	0.08	0.07	0.16	0.021	0.020
13	313	0.7	0.9	18	8	-7	36	-0.3	1.17	0.6	0.4		2.1	2.6	1.0	1.6	0.005		0.07	0.05	0.12	0.023	0.023
14	108	0.5	1.1	16	6	-8	38	0.1	0.68	0.7			2.8				0.004		0.08	0.04	0.12	0.025	0.024
15	169	2.1	2.3	6	2	-8	47	-0.2	0.24	1.0	2.0		2.8	3.5	1.3	2.2	0.003		0.12	0.05	0.18	0.018	0.014
16	186	2.6	2.7	5	0	-7	61	0.1	-0.02	1.2	3.7		3.7	4.2	1.3	2.9	0.001		0.15	0.14	0.29	0.008	0.000
17	175	1.9	2.0	5	-1	-8	64	0.0	-0.01	0.9	5.3		3.5	4.2	1.3	2.9	0.000	0.11	0.10	0.20	0.31	0.009	0.000
18	225	2.1	2.2	3	-3	-8	68	0.0	-0.01	1.3	5.0		3.6	4.3	1.4	2.9	0.000	0.10	0.11	0.30	0.42	0.019	0.000
19	226	1.3	1.4	5	-3	-7	72	0.0	-0.01	1.3	3.5		3.5	4.2	1.4	2.7	0.000	0.11	0.11	0.28	0.40	0.016	0.000
20	203	1.7	1.8	3	-3	-7	72	0.0	-0.00	1.6	4.1		3.9	4.4	1.5	2.9	0.000	0.10	0.10	0.29	0.40	0.017	0.000
21	208	2.1	2.4	4	-4	-8	71	0.0	-0.00	1.5	2.9		3.6	4.3	1.8	2.5	0.000	0.11	0.09	0.22	0.31	0.009	0.000
22	171	2.1	2.2	6	-4	-9	71	0.0	-0.00	1.5	2.6		2.8	3.5	1.3	2.1	0.000	0.09	0.08	0.13	0.21	0.002	0.000
23	221	1.3	1.5	12	-5	-9	75	0.0	0.04	1.5	2.0		2.9	3.4	1.4	2.0	0.000	0.08	0.10	0.18	0.27	0.007	0.000

DENVER, COLO.
DEC 4,1973

HOUR	VWDR	VWSP	WSPD	WSIG	TEMP	DWPT	RH	RAIN	UV	NEPH	CO	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	115	0.4	1.0	20	-3	-7	74	0.0	-0.00	2.0	3.0		4.2	4.7	2.1	2.7	0.000	0.11	0.09	0.28	0.38	0.015	0.000
01	152	0.6	0.9	13	-3	-7	74	0.0	-0.00	1.2	2.0		3.0	3.5	1.6	1.9	0.000	0.09	0.08	0.14	0.22	0.003	0.000
02	170	0.6	0.8	6	-3	-7	73	0.0	-0.00	0.8	1.5		2.9	3.3	1.4	1.9	0.000	0.09	0.08	0.13	0.21	0.002	0.000
03	226	0.4	0.6	8	-3	-7	75	0.0	-0.00	1.5	2.2		3.7	4.2	1.8	2.4	0.000	0.10	0.09	0.24	0.33	0.011	0.000
04	101	0.5	0.9	8	-4	-8	75	0.0	-0.00	1.7	2.4		4.3	4.7	1.8	2.9	0.000	0.10	0.09	0.30	0.39	0.016	0.000
05	172	0.3	0.6	8	-5	-8	79	0.0	-0.00	1.8	3.3		5.1	5.5	2.3	3.2	0.000	0.10	0.10	0.37	0.47	0.021	0.000
06	16	1.1	1.6	13	-6	-8	81	0.0	-0.00	1.7	3.8		5.0	5.3	2.4	2.9	0.000	0.10	0.09	0.36	0.46	0.021	0.000
07	20	3.9	4.0	4	-3	-11	58	0.0	0.02	0.5	1.0		2.5	2.9	1.1	1.8	0.000	0.07	0.07	0.05	0.12	0.000	0.003
08	355	0.5	1.3	20	0	-10	49	-0.2	0.41	0.7	2.1		2.7	3.1	1.3	1.9	0.000	0.08	0.07	0.09	0.16	0.002	0.003
09	52	1.5	1.8	20	2	-10	41	0.1	0.92	0.6	1.2		2.8	3.2	1.2	2.0	0.006	0.07	0.06	0.06	0.13	0.007	0.010
10	32	0.3	1.1	17	4	-10	36	0.0	1.28	0.6	0.8			3.8	1.8	2.0	0.002	0.06	0.05	0.04	0.09	0.018	0.020
11	188	1.4	1.7	14	4	-11	34	-0.1	1.16	1.8	2.3		3.0	3.5	1.4	2.1	0.000	0.13	0.15	0.04	0.19	0.028	0.024
12	196	1.8	2.0	11	4	-9	39	-0.1	1.20	2.1	2.7		2.9	3.6	1.3	2.3	0.000	0.17	0.15	0.04	0.19	0.033	0.030
13	93	0.4	1.7	26	4	-10	36	-0.1	0.99	1.6	1.6		2.7	3.0	1.1	1.9	0.000	0.14	0.12	0.02	0.14	0.041	0.034
14	309	3.4	3.8	9	4	-11	32	-0.1	0.83	0.8	0.7		2.4	2.7	1.1	1.7	0.000	0.07	0.05	0.01	0.07	0.025	0.027
15	339	3.7	3.9	8	3	-13	31	0.3	0.30	0.4	0.3		1.8	2.2	1.0	1.2	0.000	0.03	0.03	0.02	0.05	0.013	0.020
16	303	2.6	2.8	6	1	-14	34	-0.1	-0.01	0.5	0.6		2.3	2.7	1.2	1.3	0.000	0.06	0.05	0.01	0.06	0.000	0.010
17	281	4.0	4.0	4	-1	-15	36	-0.1	0.00	0.5	0.6		2.0	2.5	1.0	1.2	0.000	0.06	0.05	0.01	0.06	0.000	0.009
18	283	4.4	4.5	4	-2	-15	36	0.0	0.00	0.4	0.4		2.1	2.3	1.1	1.2	0.000	0.04	0.03	0.01	0.05	0.000	0.015
19	236	4.5	4.5	4	-1	-15	35	0.0	0.00	0.3	0.2		3.6	4.3	2.3	2.0	0.000	0.03	0.03	0.01	0.04	0.000	0.019
20	282	3.7	3.7	4	-2	-16	36	0.0	0.00	0.5	0.2		2.1	2.4	1.3	1.2	0.000	0.03	0.04	0.01	0.06	0.000	0.014
21	301	2.7	2.8	4	-3	-16	37	0.1	0.00	0.3	0.2		2.4	2.8	1.5	1.3	0.000	0.03	0.03	0.01	0.05	0.000	0.015
22	214	1.3	1.7	6	-5	-16	44	0.0	0.00	0.8	1.8		2.9	3.3	2.0	1.3	0.000	0.08	0.07	0.16	0.23	0.000	0.000
23	173	2.4	2.5	7	-6	-16	47	0.0	0.00	0.7	2.0		2.7	3.0	1.2	1.8	0.000	0.08	0.07	0.12	0.19	0.000	0.000

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DENVER, COLO.
DEC 5,1973

HOUR	VWDR	VWSP	WSPD	WSIG	TEMP	DWPT	RH	RAIN	UV	NEPH	CO	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	205	2.4	2.7	8	-6	-16	44	0.0	0.00	0.6	0.9		2.4	2.6	1.1	1.5	0.000	0.08	0.07	0.07	0.14	0.000	0.000
01	243	2.0	2.2	11	-5	-16	44		0.00	0.6	0.7		2.3	2.6	1.2	1.4	0.000	0.08	0.07	0.07	0.14	0.000	0.001
02	202	2.8	2.9	5	-7	-16	48		0.00	0.5	0.7		2.4	2.7	1.2	1.4	0.000	0.08	0.07	0.07	0.14	0.000	0.000
03	198	2.8	2.8	3	-8	-16	53	0.0	0.00	0.5	0.7		2.5	2.7	1.2	1.5	0.000	0.08	0.07	0.09	0.16	0.000	0.000
04	217	2.8	3.0	11	-8	-16	52	0.0	0.00	0.6	0.5		2.6	2.9	1.2	1.7	0.000	0.09	0.08	0.08	0.15	0.000	0.000
05	275	2.5	2.9	12	-7	-16	49	0.0	0.00	0.4	0.4		2.6	2.8	1.4	1.4	0.000	0.07	0.05	0.05	0.10	0.000	0.007
06	286	3.6	4.1	6	-4	-17	38	0.0	0.00	0.5	0.6		2.3	2.6	1.3	1.3	0.000	0.03	0.04	0.09	0.13	0.000	0.013
07	191	2.8	3.1	9	-8	-17	48	0.0	0.00	0.8	2.9		3.1	3.3	1.3	2.0	0.010	0.09	0.08	0.26	0.35	0.000	0.000
08	204	3.1	3.2	4	-6	-17	43	-0.1	0.36	1.2	4.0		3.5	3.6	1.2	2.4	0.009	0.10	0.09	0.25	0.34	0.000	0.000
09	183	3.1	3.2	6	-2	-15	39	0.0	0.80	1.6	4.8		3.8	4.0	1.3	2.7	0.005	0.15	0.13	0.20	0.33	0.000	0.002
10	262	2.8	3.3	13	1	-14	31	-0.1	1.23	1.0	2.0		2.6	3.0	1.3	1.8	0.000	0.10	0.07	0.06	0.13	0.000	0.012
11	306	5.7	5.8	5	3	-16	25	-0.1	1.53	0.5	0.2		2.1	2.4	1.4	1.0	0.000	0.01	0.02	-0.01	0.01	0.002	0.025
12	308	5.6	5.7	5	4	-15	25	0.1	1.51	0.4	0.2		1.8	2.1	1.1	1.1	0.000	0.02	0.01	-0.01	0.01	0.023	0.028
13	300	3.8	3.9	6	4	-15	25	0.1	1.23	0.5	0.2		2.3	2.5	1.3	1.2	0.000	0.03	0.02	0.00	0.02	0.005	0.027
14	29	1.3	3.5	6	3	-14	28	-0.2	0.76	0.4	0.3		2.5	2.5	1.5	1.0	0.000	0.03	0.03	0.01	0.04	0.000	0.026
15	109	3.2	3.2	11	1	-14	33	0.1	0.25	0.7								0.07	0.07	0.03	0.09	0.007	0.014
16	142	2.6	2.7	5	-1	-16	33	-0.1	-0.01	0.8	2.8		2.8	3.0	1.1	1.9	0.000	0.09	0.08	0.06	0.14	0.000	0.003
17	169	2.6	2.7	4	-3	-15	39	-0.1	0.02	1.1	3.7		2.9	3.3	1.1	2.2	0.000	0.10	0.09	0.08	0.17	0.000	0.000
18	174	2.4	2.5	3	-5	-15	45	0.1	0.01	1.0	3.1		2.9	3.2	1.1	2.1	0.000	0.12	0.10	0.10	0.20	0.000	0.000
19	172	2.6	2.7	5	-6	-15	47	0.0	0.01	1.1	3.2		3.0	3.2	1.1	2.1	0.000	0.11	0.10	0.14	0.23	0.000	0.000
20	183	2.5	2.5	4	-7	-15	51	0.0	0.00	1.1	2.8		2.9	3.2	1.1	2.1	0.000	0.10	0.09	0.15	0.24	0.000	0.000
21	174	2.4	2.4	3	-8	-16	53	0.0	0.00	1.6	3.1		3.1	3.3	1.2	2.1	0.000	0.10	0.09	0.18	0.26	0.000	0.000
22	177	2.2	2.2	4	-9	-17	56	0.0	0.00	1.3	2.2		2.7	3.0	1.1	1.8	0.000	0.09	0.08	0.11	0.19	0.000	0.000
23	175	2.3	2.3	4	-10	-17	58	0.0	0.00	1.2	2.0		2.6	2.8	1.1	1.7	0.000	0.09	0.08	0.10	0.17	0.000	0.000

DENVER, COLO.
DEC 6,1973

HOUR	VWDR	VWSP	WSPD	WSIG	TEMP	DWPT	RH	RAIN	UV	NEPH	CO	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	191	1.9	2.0	4	-11	-18	59	0.0	0.00	0.9	1.4		2.4	2.7	1.1	1.6	0.000	0.08	0.07	0.08	0.15	0.000	0.000
01	191	1.8	1.9	6	-11	-17	59	0.0	0.00	0.9	1.2		2.5	2.8	1.2	1.5	0.008	0.09	0.08	0.12	0.20	0.000	0.000
02	215	1.7	1.8	6	-11	-18	58	0.0	0.00	0.7	0.7		2.3	2.4	1.2	1.3	0.005	0.08	0.08	0.09	0.16	0.000	0.000
03	202	2.7	2.7	4	-10	-17	55	0.0	0.00	0.5	0.5		2.2	2.4	1.2	1.2	0.011	0.09	0.07	0.07	0.14	0.000	0.000
04	204	2.7	2.8	3	-10	-18	53	0.0	0.00	0.6	0.3		2.2	2.4	1.2	1.2	0.021	0.09	0.07	0.08	0.15	0.000	0.000
05	210	2.7	2.7	5	-9	-18	51	0.0	0.00	0.5	0.4		2.4	2.5	1.3	1.3	0.025	0.08	0.07	0.03	0.10	0.000	0.000
06	214	3.1	3.2	5	-9	-18	49	0.0	-0.00	0.5	0.8		2.4	2.7	1.3	1.4	0.026	0.08	0.07	0.07	0.13	0.000	0.000
07	209	2.3	2.4	7	-7	-17	47	0.0	-0.01	0.6	2.1		2.7	2.9	1.2	1.7	0.020	0.09	0.08	0.12	0.20	0.000	0.000
08	209	3.3	3.3	4	-3	-16	37	0.0	0.35	0.7	3.4		3.0	3.1	1.2	1.9	0.013	0.10	0.09	0.11	0.20	0.000	0.002
09	204	3.4	3.5	5	-0	-15	34	0.0	0.84	0.8	2.1		2.8	3.1	1.3	1.8	0.020	0.09	0.08	0.09	0.17	0.000	0.007
10	196	2.9	3.0	5	2	-14	31	-0.2	1.26	0.5	1.3		2.4	2.6	1.1	1.5	0.014	0.07	0.07	0.04	0.11	0.000	0.016
11	194	2.0	2.1	8	6	-13	26	-0.2	1.43	0.4	1.5		2.3	2.7	1.2	1.5	0.006	0.09				0.013	0.024
12	181	0.9	1.2	15	9	-10	26	0.0	1.34	0.7	1.6		2.4	2.9	1.2	1.6	0.002	0.10	0.08	0.01	0.09	0.028	0.035
13	151	1.6	1.8	9	7	-11	27	-0.1	1.11	0.8	1.9		2.4	2.9	1.2	1.7	0.000	0.11	0.09	0.01	0.10	0.027	0.035
14	150	1.1	1.3	15	8	-10	28	-0.1	0.68	0.8	1.7		2.6	3.0	1.2	1.8	0.000	0.11	0.09	0.01	0.11	0.026	0.033
15	302	0.6	0.7	21	9	-11	24	0.2	0.21	1.1	1.5		2.8	3.1	1.3	1.7	0.000	0.11	0.10	0.01	0.11	0.022	0.029
16	204	0.6	0.9	12	6	-12	26		-0.03	1.8	5.4		4.6	5.1	2.0	3.1	0.003	0.15	0.16	0.33	0.50	0.007	0.009
17	201	2.3	2.3	3	3	-10	40	-0.1	0.00	1.4	8.8		4.7	5.1	1.4	3.7	0.002	0.11	0.10	0.34	0.45	0.000	0.000
18	189	3.7	3.7	3	1	-9	47	-0.1	0.00	1.2	5.5		3.9	4.3	1.3	3.0	0.016	0.10	0.09	0.30	0.40	0.000	0.000
19	192	3.5	3.5	2	-0	-10	51	0.0	0.00	1.2	3.2		3.1	3.5	1.2	2.4	0.024	0.10	0.09	0.24	0.33	0.000	0.000
20	195	3.8	3.8	3	-1	-10	50	0.0	-0.00	1.0	2.3		2.7	3.1	1.1	2.0	0.012	0.10	0.08	0.13	0.21	0.000	0.000
21	199	4.5	4.5	2	-1	-11	49	0.0	-0.00	0.9	1.3		2.4	2.8	1.1	1.7	0.011	0.09	0.08	0.10	0.18	0.000	0.000
22	199	4.5	4.5	2	-1	-11	47	0.0	-0.00	0.8	1.0		2.4	2.7	1.1	1.6	0.014	0.08	0.07	0.06	0.14	0.000	0.000
23	215	2.2	2.4	6	-1	-11	48	0.0	0.00	1.0	1.0		2.6	2.9	1.2	1.7	0.014	0.08	0.07	0.10	0.18	0.000	0.000

DENVER, COLO.
DEC 7,1973

HOUR	VWDR	VWSP	WSPD	WSIG	TEMP	DWPT	RH	RAIN	UV	NEPH	CC	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	226	1.8	1.9	5	-3	-11	54	-0.1	0.01	1.2	1.4		2.8	3.2	1.3	1.9	0.015	0.09	0.08	0.16	0.24	0.000	0.000
01	234	1.3	1.4	8	-4	-11	56		0.01	1.3	1.3		2.7	3.0	1.2	1.8	0.007	0.10	0.09	0.16	0.25	0.000	0.000
02	138	1.9	2.0	5	-3	-11	55		0.01	0.7	0.5		2.4	2.8	1.2	1.6	0.020	0.08	0.06	0.04	0.11	0.000	0.000
03	198	2.9	2.9	3	-2	-11	53	0.1	0.01	0.5	0.4		2.1	2.6	1.1	1.5	0.010	0.07	0.06	0.01	0.07	0.000	0.002
04	199	4.2	4.2	2	-1	-11	50	0.0	0.00	0.7	0.1		2.2	2.6	1.1	1.4	0.017	0.07	0.06	0.01	0.07	0.000	0.003
05	203	4.8	4.8	2	-1	-11	49	0.0	0.00	0.5	0.1		2.0	2.5	1.1	1.3	0.016	0.08	0.05	0.00	0.06	0.000	0.005
06	204	4.6	4.6	3	-1	-10	50	0.0	0.00	0.5	0.5		2.2	2.6	1.1	1.5	0.009	0.09	0.06	0.04	0.10	0.000	0.001
07	203	3.6	3.7	3	0	-9	50	-0.1	-0.01	0.8	1.9		2.9	3.3	1.3	2.0	0.021	0.09	0.07	0.11	0.18	0.000	0.001
08	202	4.5	4.5	3	4	-8	43	0.0	0.34	0.7	2.7		3.0	3.4	1.1	2.2	0.022	0.09	0.08	0.11	0.19	0.000	0.003
09	156	3.5	3.5	4	6	-7	42	0.0	0.88	0.6								0.07	0.10	0.06	0.13	0.001	0.010
10	200	3.6	3.6	4	9	-6	34	-0.3	1.24	0.6								0.06	0.07	0.05	0.12	0.005	0.015
11	202	3.9	4.0	4	10	-6	32	-0.1	1.41	0.7	1.2		2.4	2.9	1.2	1.7	0.012		0.07	0.06	0.14	0.004	0.015
12	205	2.1	2.2	7	14	-4	30	-0.1	1.36	0.9	1.9		2.8	3.4	1.3	2.1	0.011		0.10	0.03	0.13	0.020	0.031
13	210	2.7	2.7	5	14	-4	29	0.1	1.13	0.9	2.0		2.9	3.3	1.2	2.1	0.009	0.12	0.11	0.03	0.15	0.019	0.030
14	223	1.1	1.3	8	15	-4	27	0.0	0.55	1.2	2.6		3.2	3.6	1.2	2.4	0.011	0.15	0.15	0.09	0.25	0.012	0.018
15	235	0.4	1.2	18	11	-4	36	-0.1	0.07	2.1	5.6		6.3	6.5	2.7	3.8	0.011	0.20	0.17	0.30	0.48	0.003	0.001
16	250	0.5	1.5	16	9	-3	43	0.1	-0.02	2.0	6.5		9.5	9.2	3.5	5.7	0.013	0.15	0.14	0.37	0.51	0.004	0.000
17	133	0.7	1.6	23	8	-4	45	-0.1	0.01	2.3	12.0		8.1	8.8	2.7	6.1	0.008	0.14	0.12	0.53	0.65	0.008	0.000
18	205	2.9	3.1	6	7	-3	48	0.0	-0.00	2.3	12.9		7.2	7.7	1.5	6.2	0.010	0.13	0.13	0.64	0.77	0.010	0.000
19	207	3.2	3.4	5	6	-3	50	0.0	-0.00	1.2	5.1		4.4	4.9	1.3	3.7	0.012	0.11	0.11	0.33	0.44	0.000	0.000
20	180	2.3	2.6	12	5	-4	53	0.0	-0.00	1.2	4.7		4.4	4.8	1.4	3.4	0.010	0.09	0.09	0.32	0.41	0.000	0.000
21	275	3.3	4.0	7	7	-3	51	0.0	0.00	0.9	3.1		4.4	4.6	1.6	3.0	0.011	0.07	0.07	0.23	0.30	0.000	0.002
22	300	5.2	5.4	3	11	-4	35	-0.1	0.00	0.1	0.1		2.4	3.7	2.0	1.7	0.008	0.00	0.03	0.03	0.05	0.004	0.016
23	291	3.9	4.0	5	10	-5	35	0.0	0.00	0.2	0.0		4.2	4.5	2.3	2.3	0.010	0.00	0.03	0.04	0.07	0.002	0.014

DENVER, COLO.
DEC 8,1973

HOUR	VWDR	VWSP	WSPD	WSIG	TEMP	DWPT	RH	RAIN	UV	NEPH	CC	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	275	4.6	4.7	3	10	-5	34	0.0	0.00	0.2	0.0		1.9	2.5	0.9	1.6	0.004	0.01	0.04	0.04	0.08	0.002	0.013
01	274	4.4	4.6	6	9	-6	34	0.2	0.00	0.2	0.0		2.0	3.0	1.1	1.9	0.003	-0.01	0.03	0.03	0.06	0.007	0.019
02	291	6.1	6.3	3	10	-6	32	0.4	0.00	0.1	-0.1		2.1	2.4	0.8	1.6	0.001	-0.03	0.01	0.03	0.04	0.012	0.025
03	264	0.3	2.1	13	7	-6	38	0.0	0.00	0.2	0.1		2.4	3.0	1.0	2.0	0.000	-0.00	0.04	0.04	0.08	0.005	0.015
04	130	1.5	2.0	18	7	-6	39	0.0	0.00	0.3	0.1		2.4	3.1	1.1	2.0	0.000	0.03	0.06	0.05	0.10	0.000	0.008
05	269	2.9	3.4	9	8	-7	35	0.0	0.00	0.2	-0.0		2.5	2.7	0.9	1.8	0.001	-0.00	0.03	0.03	0.06	0.007	0.020
06	341	0.7	1.7	17	7	-8	36	0.0	0.00	0.3	0.1		2.6	3.2	1.0	2.2	0.006	0.00	0.04	0.04	0.07	0.004	0.016
07	38	0.5	1.4	16	4	-7	44	0.0	0.00	0.5	0.5		3.5	4.0	1.5	2.5	0.011	0.04	0.08	0.09	0.16	0.000	0.005
08	125	1.4	2.0	18	9	-6	36	-0.1	0.31	0.4	1.0		2.5	3.0	1.1	1.9	0.002	0.03	0.06	0.07	0.13	0.000	0.010
09	160	3.2	3.4	7	9	-6	35	-0.3	0.77	0.6	1.1		2.4	2.9	1.1	1.8	0.000	0.07	0.05	0.04	0.09	0.003	0.015
10	129	1.5	2.4	12	11	-5	33	-0.2	1.12		1.2		2.2	2.9	1.1	1.8	0.000	0.07	0.05	0.03	0.08	0.007	0.018
11	343	2.4	3.2	13	13	-5	28	0.2	1.27		0.6			3.9	1.1	2.8	0.008		0.05	0.01	0.06	0.023	0.032
12	294	6.1	6.3	6	13	-6	27	-0.1	1.33	0.3	0.1		2.7	3.4	1.6	1.8	0.000		0.01	0.00	0.02	0.019	0.029
13	298	6.7	6.8	6	12	-6	28	0.1	1.10	0.2	0.1		2.4	2.6	1.2	1.4	0.000		0.02	0.01	0.03	0.016	0.023
14	287	5.0	5.2	6	12	-7	26	0.0	0.71	0.2	0.1		2.3	2.5	1.2	1.3	0.000		0.01	0.01	0.03	0.018	0.029
15	1	2.0	4.0	8	10	-8	28	0.0	0.26	0.1	0.1		2.8	2.7	1.3	1.4	0.000		0.02	0.01	0.03	0.016	0.029
16	116	3.9	4.1	11	5	-6	46	0.0	-0.01	0.2	0.4		1.9	2.4	0.9	1.5	0.000		0.03	0.01	0.05	0.004	0.016
17	145	2.2	2.3	7	3	-6	52	0.0	0.00	0.3	0.8		2.1	2.6	1.0	1.7	0.000		0.05	0.03	0.08	0.000	0.005
18	169	1.0	1.2	9	2	-6	57	0.0	0.00	0.4	1.1		2.3	2.7	1.0	1.7	0.000		0.06	0.05	0.11	0.000	0.001
19	139	0.2	0.6	8	0	-6	61	0.0	0.00	0.6	2.1		2.9	3.3	1.2	2.0	0.000		0.06	0.14	0.20	0.000	0.000
20	71	1.6	1.8	7	-0	-6	64	0.0	0.00	0.6	1.7		3.4	3.9	1.7	2.2	0.000		0.05	0.11	0.16	0.000	0.001
21	65	1.3	1.3	7	-1	-7	66	0.0	0.00	0.4	0.4		2.4	2.9	1.2	1.7	0.000		0.05	0.03	0.08	0.000	0.002
22	87	0.8	1.0	16	-2	-7	69	0.0	0.00	0.4	0.5		2.5	3.0	1.2	1.8	0.000		0.05	0.04	0.09	0.000	0.001
23	69	0.6	0.7	19	-2	-7	67	0.0	0.00	0.2	0.4		2.1	2.6	1.1	1.5	0.000		0.04	0.02	0.06	0.000	0.008

DENVER, COLO.
DEC 9,1973

HOUR	VWDP	VWSP	WSPD	WSTG	TEMP	DWPT	RH	PAIN	UV	NEPH	CC	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	107	1.0	1.1	15	-2	-7	67	0.0	0.00	0.2	0.2		2.1	2.5	1.1	1.4	0.000		0.04	0.02	0.06	0.000	0.009
01	131	2.2	2.3	7	-1	-7	65	0.0	-0.00	0.2	0.4		1.9	2.5	1.0	1.4	0.000		0.03	0.02	0.05	0.001	0.013
02	123	2.1	2.2	8	-2	-8	63	0.0	0.00	0.2	0.2		1.9	2.4	1.0	1.4	0.000		0.02	0.02	0.04	0.004	0.016
03	103	1.9	1.9	7	-2	-8	64	0.0	0.00	0.2	0.1		1.9	2.4	1.0	1.4	0.000		0.02	0.02	0.03	0.008	0.021
04	100	2.2	2.3	7	-2	-9	63	0.0	0.00	0.2	0.1		1.9	2.4	1.0	1.4	0.000		0.02	0.02	0.04	0.008	0.021
05	92	1.7	1.8	7	-3	-10	60	0.0	0.00	0.2	0.1		2.1	2.6	1.2	1.4	0.000		0.02	0.02	0.03	0.008	0.021
06	146	2.0	2.0	5	-3	-9	64	0.0	0.00	0.2	0.2		1.9	2.4	1.1	1.4	0.000		0.03	0.02	0.05	0.002	0.014
07	125	1.9	2.0	6	-3	-10	63	0.0	0.00	0.2	1.0		2.2	2.7	1.2	1.6	0.000		0.04	0.03	0.07	0.000	0.009
08	112	2.2	2.3	7	-1	-9	56	0.1	0.32	0.3	0.7		2.1	2.6	1.1	1.5	0.000		0.04	0.03	0.07	0.001	0.014
09	85	2.1	2.2	16	1	-8	53	-0.2	0.74	0.3	0.4		2.0	2.6	2.7	-0.1	0.000		0.02	0.02	0.04	0.007	0.021
10	76	2.5	2.6	15	0	-9	52	0.0	0.86	0.5	0.2		2.0	2.6	1.4	1.3	0.000		0.01	0.00	0.01	0.015	0.027
11	84	2.2	2.3	10	-0	-8	55	-0.1	1.10	0.6	0.1		1.6	2.4	1.3	1.1	0.000		0.01	-0.00	0.01	0.017	0.029
12	118	1.5	1.7	19	2	-7	53	0.1	1.24	0.7			1.8				0.000					0.022	0.033
13	159	1.2	1.6	24	3	-7	49	0.0	1.02	0.6			1.8				0.000					0.025	0.037
14	151	2.3	2.5	9	3	-8	48	0.3	0.63	0.6	0.5		1.9	2.4	1.0	1.4	0.000	-0.01	0.03	0.02	0.04	0.027	0.038
15	126	1.6	1.8	10	2	-8	49	0.2	0.23	0.8	0.7		1.9	2.5	1.1	1.5	0.000		0.04	0.01	0.04	0.024	0.035
16	209	1.5	1.6	6	1	-9	48	0.1	-0.01	0.8	0.8		2.1	2.6	1.1	1.6	0.000		0.06	0.02	0.08	0.012	0.020
17	225	2.3	2.3	4	-1	-8	58	0.0	0.00	1.1	1.3		2.3	2.9	1.2	1.7	0.000		0.10	0.06	0.15	0.000	0.000
18	192	2.0	2.0	4	-1	-8	61	0.0	0.00	1.0	1.6		2.5	3.0	1.2	1.8	0.000		0.09	0.09	0.17	0.000	0.000
19	198	2.4	2.4	4	-2	-8	64	0.0	0.00	1.4	1.8		2.8	3.3	1.4	1.9	0.003		0.09	0.11	0.20	0.000	0.000
20	193	2.7	2.7	3	-3	-8	69	0.0	0.00	1.8	1.6		2.8	3.2	1.3	1.9	0.006		0.09	0.11	0.19	0.000	0.000
21	190	2.5	2.6	3	-3	-8	69	0.0	0.00	1.5	1.2		2.6	3.0	1.3	1.7	0.007		0.08	0.08	0.16	0.000	0.000
22	184	1.9	2.0	5	-4	-9	68	0.0	0.00	2.5	2.0		2.8	3.1	1.2	1.9	0.000		0.08	0.13	0.21	0.000	0.000
23	185	1.5	1.5	5	-5	-10	66	0.0	0.00	1.5	1.8		2.7	2.9	1.2	1.7	0.000		0.07	0.11	0.17	0.000	0.000

DENVER, COLO.
DEC 10,1973

HOUR	VWDP	VWSP	WSPC	WSIG	TEMP	DWPT	RH	RAIN	UV	RFPH	CO	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	175	2.0	2.0	3	-5	-11	64	0.0	0.00	1.3	1.4		2.6	2.7	1.2	1.6	0.000		0.07	0.11	0.17	0.000	0.000
01	176	1.3	1.5	7	-5	-11	62	0.0	0.00	0.7	0.9		2.5	2.6	1.2	1.4	0.000		0.07	0.06	0.12	0.000	0.000
02	199	3.4	3.6	11	-4	-11	60	0.0	0.00	0.9	0.7		2.8	3.0	1.5	1.5	0.013		0.08	0.21	0.28	0.000	0.000
03	193	4.7	4.7	3	-2	-12	51	0.0	0.00	0.5	0.2		2.2	2.4	1.2	1.2	0.022		0.07	0.07	0.13	0.000	0.000
04	208	2.2	2.5	5	-2	-12	48	0.0	0.00	0.4	0.1		2.7	2.9	1.3	1.6	0.017		0.06	0.04	0.10	0.000	0.003
05	220	0.9	1.1	11	-3	-12	53	0.0	0.00	0.8	0.8		4.0	4.6	2.9	1.7	0.013		0.07	0.13	0.20	0.000	0.000
06	241	1.1	1.5	19	-3	-11	54	0.0	0.00	1.1	2.6		3.6	3.8	1.6	2.3	0.008		0.07	0.40	0.47	0.000	0.000
07	206	1.4	1.6	10	-2	-10	57	0.0	-0.00	1.1	4.1		3.8	4.2	1.4	2.8	0.010		0.07	0.35	0.41	0.000	0.000
08	200	2.6	2.6	5	4	-9	39	-0.4	0.32	0.9	3.8		3.5	3.6	1.1	2.5	0.011		0.10	0.20	0.30	0.000	0.001
09	194	2.6	2.6	7	7	-10	30	0.0	0.68	0.7	2.4		2.8	3.0	1.0	2.0	0.007		0.10	0.12	0.21	0.000	0.004
10	209	2.0	2.3	7	9	-10	26	0.0	0.80	0.8	1.9		2.9	3.1	1.0	2.1	0.012		0.10	0.12	0.21	0.000	0.004
11	203	2.5	2.6	8	12	-9	23	-0.1	1.10	1.1	2.6		3.2	3.4	1.1	2.3	0.024		0.13	0.12	0.24	0.000	0.006
12	204	2.2	2.3	7	13	-9	22	0.1	1.00	1.0	2.7		3.1	3.5	1.1	2.4	0.019		0.14	0.09	0.22	0.001	0.008
13	191	1.5	2.2	12	16	-10	17	-0.2	1.00	1.0	2.3		3.0	3.4	1.1	2.2	0.006		0.12	0.05	0.16	0.010	0.020
14	234	1.7	2.1	6	13	-10	21	0.0	0.23	1.9	4.2		4.0	4.2	1.2	3.0	0.012		0.15	0.27	0.41	0.000	0.001
15	218	0.8	1.3	23	11	-8	28	0.1	0.03	3.2	7.4		5.6	5.6	1.4	4.2	0.011		0.18	0.51	0.67	0.006	0.000
16	280	2.7	2.9	8	12	-10	23	0.0	-0.02	1.8	6.0		4.5	4.6	1.6	3.1	0.004		0.12	0.22	0.33	0.001	0.000
17	280	5.1	5.1	4	12	-15	14	-0.1	0.00	0.5	0.9		2.5	3.1	1.2	1.9	0.000		0.06	0.02	0.08	0.000	0.002
18	236	5.1	5.2	5	12	-16	13	0.1	-0.00	0.4	0.2		3.0	2.9	1.4	1.5	0.001		0.03	0.03	0.06	0.008	0.007
19	286	2.0	3.2	7	10	-16	15	0.0	-0.00	0.5	0.8		3.6	3.6	1.8	1.8	0.003		0.05	0.09	0.13	0.005	0.006
20	183	2.8	3.0	13	8	-13	23	0.0	-0.00	0.9	2.6		3.0	3.2	1.1	2.1	0.005		0.08	0.16	0.24	0.000	0.000
21	179	3.4	3.5	3	5	-10	35	0.1	-0.00	1.0	1.9		2.8	3.0	1.0	2.0	0.007		0.08	0.14	0.22	0.000	0.000
22	189	3.9	4.0	3	4	-10	35	0.0	-0.00	0.9	1.4		2.5	2.8	1.0	1.8	0.005		0.08	0.13	0.21	0.000	0.000
23	174	3.4	3.5	3	4	-11	33	0.0	0.00	0.8	1.3		2.5	2.6	1.0	1.6	0.007		0.08	0.10	0.17	0.000	0.000

DENVER, COLO.
DEC 11,1973

HOUR	VWDR	VWSP	WSPD	WSIG	TEMP	DWPT	RH	RAIN	UV	NEPH	CO	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	198	2.6	2.7	5	4	-11	34	0.0	0.00	0.6	0.9		2.4	2.6	1.0	1.6	0.000		0.07	0.08	0.15	0.000	0.000
01	199	1.4	1.7	9	3	-11	38	0.0	0.00	0.7	1.0		2.9	2.9	1.2	1.7	0.000		0.08	0.11	0.18	0.000	0.000
02	201	2.4	2.5	4	3	-10	39	0.0	0.00	0.5	0.5		2.5	2.8	1.1	1.7	0.008		0.07	0.06	0.13	0.000	0.000
03	222	1.2	1.5	14	3	-11	38	0.0	0.00	0.7	0.6		2.9	3.2	1.3	1.9	0.008		0.08	0.10	0.18	0.000	0.000
04	152	0.8	1.4	12	1	-9	46	0.0	0.00	1.0	1.0		4.6	4.7	1.8	3.0	0.009		0.09	0.18	0.27	0.000	0.000
05	241	0.8	1.0	16	1	-9	49	0.0	-0.00	1.0	1.1		8.4	8.1	3.9	4.2	0.018		0.08	0.20	0.28	0.000	0.000
06	150	0.7	1.6	15	2	-8	48	0.1	-0.00	1.2	2.6		8.2	7.7	4.3	3.3	0.021		0.08	0.31	0.38	0.000	0.000
07	186	1.3	1.8	17	3	-9	43	0.0	-0.01	1.4	5.2		6.0	5.3	1.9	3.4	0.014		0.08	0.42	0.50	0.000	0.000
08	181	0.6	1.1	27	5	-7	42	-0.1	0.24	1.7	7.5		5.7	5.5	1.6	3.9	0.009		0.12	0.45	0.56	0.000	0.000
09	186	2.2	2.4	13	8	-7	33	0.1	0.53	1.6	6.6		4.5	5.0	1.3	3.7	0.007		0.16	0.30	0.44	0.000	0.000
10	118	1.0	1.9	15	10	-9	26	-0.1	0.54	1.4	3.5		3.8	3.9	1.2	2.7	0.008		0.12	0.14	0.26	0.000	0.001
11	148	0.6	0.8	14	11	-7	28	0.1	0.68	1.9	3.2		5.8	5.9	1.6	4.3	0.006		0.17	0.10	0.26	0.002	0.003
12	153	1.6	1.7	11	12	-9	23	-0.1	0.74	1.3	3.3		3.2	3.8	1.2	2.6	0.000	0.16	0.14	0.10	0.23	0.000	0.002
13	202	0.8	0.9	10	13	-9	22	0.0	0.62	1.2	2.4		2.9	3.2	1.0	2.2	0.000	0.13	0.13	0.07	0.18	0.000	0.003
14	301	1.3	1.4	8	13	-6	27	-0.1	0.39	6.8	7.8		8.8	10.0	4.4	5.6	0.014	0.36	0.38	0.16	0.51	0.003	0.001
15	149	1.1	1.4	13	12	-5	31	-0.2	0.15	8.7	10.6		7.8	7.8	3.1	4.7	0.016	0.51	0.47	0.28	0.71	0.006	0.000
16	156	0.7	1.3	14	11	-5	33	0.3	-0.02	8.7	13.2		9.3	8.6	2.7	5.9	0.014	0.51	0.43	0.44	0.84	0.009	0.000
17	174	2.0	2.1	6	8	-7	36	0.1	0.01	3.0	12.2		6.5	6.7	1.5	5.2	0.003	0.25	0.18	0.48	0.65	0.002	0.000
18	229	1.3	2.0	5	6	-6	42	0.0	0.01	5.9	16.4		10.5	10.2	2.8	7.4	0.010	0.29	0.30	0.76	1.03	0.012	0.000
19	173	0.8	1.6	15	4	-6	47	0.0	0.01	5.7	16.0		10.8	11.0	2.8	8.2	0.009	0.31	0.26	0.75	1.00	0.011	0.000
20	247	1.8	2.2	11	3	-6	50	0.0	0.00	4.2	11.8		8.6	7.9	2.9	5.6	0.005	0.21	0.16	0.57	0.72	0.005	0.000
21	184	2.2	2.6	6	4	-8	44	-0.1	0.00	2.0	4.8		4.3	4.9	1.3	3.6	0.000	0.12	0.11	0.32	0.41	0.000	0.000
22	196	3.3	3.4	5	6	-10	31	0.0	0.00	1.2	2.4		3.3	3.6	1.1	2.4	0.000	0.10	0.09	0.16	0.25	0.000	0.000
23	190	3.3	3.3	3	6	-11	29	0.0	0.00	0.8	1.1		2.7	3.0	1.1	1.9	0.000	0.09	0.08	0.07	0.14	0.000	0.000

DENVER, COLO.
DEC 12,1973

HOUR	VWDR	VWSP	WSPD	WSIG	TEMP	DWPT	RH	RAIN	UV	NEPH	CC	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	198	3.9	4.0	2	6	-12	28	0.0	0.00	0.7	0.5		2.4	2.8	1.1	1.7	0.000	0.09	0.07	0.04	0.11	0.000	0.000
01	192	4.4	4.4	3	6	-11	30	0.0	0.00	0.5	0.2		2.1	2.5	1.0	1.6	0.000	0.08	0.07	0.04	0.09	0.000	0.000
02	219	2.6	3.0	6	5	-10	34	0.0	0.00	0.7	0.3		3.0	2.6	1.0	1.6	0.001	0.08	0.07	0.03	0.09	0.000	0.000
03	211	1.9	2.2	8	4	-11	34	0.1	0.00	0.9	0.5		2.5	2.8	1.1	1.8	0.000	0.10	0.08	0.08	0.15	0.000	0.000
04	283	3.6	3.7	6	5	-10	32	0.1	0.00	0.7	0.2		3.6	2.5	1.1	1.5	0.002	0.07	0.04	0.01	0.05	0.002	0.006
05	303	10.4	10.6	4	7	-9	31	0.3	-0.00	0.9	0.1		2.1	2.4	1.0	1.4	0.000	0.03	0.02	0.01	0.02	0.009	0.015
06	283	11.8	11.9	4	4	-15	25	-0.2	0.00	0.6	0.2		1.9	2.3	0.9	1.4	0.000	0.03	0.02	0.01	0.03	0.011	0.019
07	290	7.0	7.4	8	4	-16	23	-0.1	-0.03	0.6	0.1		1.9	2.2	1.0	1.2	0.000	0.04	0.02	0.01	0.03	0.013	0.021
08	332	7.1	7.3	6	5	-15	24	0.0	0.17	0.9	0.2		1.7	2.0	0.9	1.1	0.000	0.04	0.03	0.03	0.05	0.009	0.018
09	320	3.7	5.1	12	7	-13	23	0.1	0.66	0.8	0.2		1.9	2.3	1.1	1.2	0.001	0.06	0.04	0.03	0.07	0.007	0.016
10	294	9.3	9.4	5	9	-13	21	-0.2	1.05	0.7	0.1		2.3	2.6	1.4	1.2	0.000	0.04	0.02	0.01	0.03	0.008	0.020
11	295	10.0	10.1	4	8	-13	21	0.1	1.25	0.6	0.3		2.3	2.7	1.3	1.4	0.000	0.02	0.02	0.01	0.02	0.010	0.022
12	313	8.3	8.5	5	9	-13	21	0.3	1.04	0.5	0.2		1.9	2.2	1.1	1.1	0.000	0.01	0.02	0.00	0.02	0.013	0.024
13	324	7.6	7.8	6	9	-13	20	-0.3	0.85	0.5	0.2		1.7	2.1	1.0	1.1	0.000	0.01	0.02	0.00	0.02	0.016	0.026
14	325	6.3	6.3	5	8	-14	20	0.2	0.44	0.5	0.1		1.7	2.0	1.0	1.1	0.000		0.02	0.00	0.02	0.016	0.030
15	316	7.6	7.6	5	9	-14	19	-0.1	0.22	0.6	0.2		1.7	2.0	0.8	1.2	0.000	0.03				0.014	0.028
16	316	9.0	9.1	4	8	-15	19	0.2	-0.02	0.5	0.3		1.7	2.1	0.9	1.2	0.000	0.02	0.02	0.00	0.02	0.012	0.025
17	311	6.7	6.8	4	7	-14	21	0.0	0.00	0.6	0.3		2.1	2.2	1.0	1.3	0.000	0.03	0.03	-0.00	0.02	0.011	0.023
18	315	3.4	4.0	12	6	-15	21	0.0	-0.00	0.7	0.3		1.8	2.1	0.9	1.2	0.000	0.05	0.03	0.01	0.05	0.008	0.018
19	154	0.6	2.0	13	5	-15	22	0.0	-0.00	0.7	0.8		2.1	2.4	1.0	1.4	0.000	0.08	0.06	0.02	0.08	0.003	0.010
20	223	1.6	2.0	9	5	-14	24	0.0	0.00	0.8	0.8		2.2	2.5	1.0	1.5	0.000	0.10	0.07	0.04	0.11	0.000	0.004
21	207	0.7	2.7	22	5	-13	29	0.0	-0.00	0.9	1.3		2.5	2.8	1.0	1.8	0.000	0.10	0.07	0.06	0.13	0.000	0.003
22	8	1.4	2.6	9	3	-11	36	0.0	0.00	1.0	1.7		3.3	3.7	1.3	2.4	0.008	0.11	0.07	0.08	0.15	0.001	0.005
23	302	1.6	2.6	10	6	-11	31	0.0	0.00	0.7	0.3		2.0	2.4	1.0	1.4	0.000	0.07	0.05	0.02	0.06	0.006	0.014

DENVER, COLO.
DEC 13,1973

HOUR	VWDP	VWSP	WSPD	WSIG	TEMP	DWPT	RH	RAIN	UV	NEPH	CO	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	195	2.4	2.5	8	3	-11	37	0.0	0.00	0.9	1.5		2.7	3.1	1.1	2.0	0.000	0.11	0.08	0.08	0.15	0.000	0.000
01	193	3.0	3.0	3	1	-10	43	0.0	0.00	0.9	0.9		2.6	3.0	1.1	1.8	0.000	0.10	0.07	0.05	0.12	0.000	0.000
02	185	2.1	2.2	4	1	-10	43	0.0	0.00	0.8	0.6		2.4	2.8	1.1	1.7	0.000	0.10	0.07	0.04	0.10	0.000	0.000
03	166	1.8	2.2	18	2	-10	42	0.0	0.00	0.7	0.5		2.3	2.7	1.1	1.7	0.000	0.10	0.07	0.03	0.09	0.000	0.000
04	163	1.9	2.5	23	1	-10	46	0.0	0.00	0.6	0.5		2.1	2.6	1.0	1.6	0.000	0.09	0.05	0.01	0.06	0.000	0.005
05	141	1.5	2.5	27	0	-9	51	0.0	0.00	0.6	0.4		2.1	2.5	1.0	1.5	0.000	0.08	0.05	0.02	0.07	0.000	0.003
06	194	2.1	2.3	6	-0	-9	53	0.0	0.00	0.7	0.9		2.3	2.7	1.0	1.7	0.000	0.09	0.06	0.07	0.13	0.000	0.000
07	208	0.6	1.3	20	-0	-8	56	0.0	-0.02	1.6	4.1		5.7	6.0	2.3	3.7	0.003	0.11	0.08	0.36	0.44	0.000	0.000
08	142	0.2	1.4	28	1	-7	55	0.0	0.21	2.5	7.8		6.3	6.2	2.0	4.2	0.000	0.15	0.10	0.50	0.60	0.001	0.000
09	153	0.6	1.6	28	6	-5	46	-0.3	0.61	2.1	5.5		4.9	5.4	1.3	4.0	0.004	0.18	0.14	0.24	0.37	0.000	0.001
10	171	1.6	1.8	17	9	-4	40	0.0	0.96	1.6	2.8		3.4	4.1	1.0	3.1	0.006	0.18	0.14	0.09	0.23	0.000	0.007
11	180	1.1	1.6	16	12	-4	34	0.0	0.91	1.9	2.7		3.4	3.8	1.1	2.7	0.012	0.22	0.18	0.10	0.27	0.000	0.008
12	169	1.7	2.2	13	12	-4	34	0.0	0.83	1.5	4.5		3.0	4.1	1.8	2.3	0.013	0.19	0.14	0.07	0.20	0.000	0.007
13	167	1.4	2.0	11	12	-4	31	0.0	0.32	1.5	4.8		3.4	4.5	1.8	2.7	0.009	0.14	0.11	0.10	0.21	0.000	0.002
14	96	1.1	1.5	13	11	-3	37	-0.1	0.24	2.1	6.6		4.0	5.6	2.2	3.3	0.003	0.17	0.16	0.11	0.26	0.000	0.001
15	209	0.8	1.3	19	11	-2	40	0.0	0.07	2.7	7.4			6.5	2.4	4.1		0.19	0.16	0.19	0.34	0.000	0.000
16	182	1.1	1.6	20	10	-3	41	0.0	-0.02	2.7	10.4			6.0	2.5	3.5		0.16	0.15	0.23	0.37	0.000	0.000
17	43	0.4	1.7	15	7	-3	49	0.0	-0.00	2.6	13.2			6.2	2.2	3.9		0.13	0.11	0.35	0.45	0.000	0.000
18	61	0.8	1.2	25	4	-3	61	0.0	0.00	2.1	7.4			7.0	2.5	4.5		0.08	0.08	0.29	0.37	0.000	0.000
19	157	0.8	1.7	13	4	-3	62	0.0	0.00	2.1	9.5			7.9	3.3	4.6		0.09	0.09	0.37	0.46	0.000	0.000
20	311	0.3	1.1	13	3	-4	61	0.0	0.00	2.4	9.9			9.1	5.3	3.8		0.09	0.08	0.41	0.49	0.001	0.000
21	168	0.4	1.3	14	2	-4	66	0.0	0.00	3.1	12.0			11.8	8.2	3.6		0.10	0.09	0.57	0.66	0.004	0.000
22	121	0.3	1.5	14	2	-4	66	0.0	0.00	2.5	13.0			10.5	7.2	3.3		0.09	0.07	0.44	0.52	0.002	0.000
23	34	3.2	3.4	7	2	-5	60	0.0	0.00	0.9	3.0			4.3	2.6	1.8		0.04	0.04	0.02	0.06	0.000	0.003

DENVER, COLO.
DEC 14,1973

HOUR	VWDR	VWSP	WSPD	WSIG	TEMP	DWPT	RH	RAIN	UV	NEPH	CO	*CO	HC	THC	CH4	NMHC	SO2	*NO2	NO2	NO	NOX	OXID	O3
00	84	1.3	1.8	19	-0	-6	68	0.0	0.00	0.9	0.9			3.5	2.2	1.3		0.05	0.06	0.03	0.09	0.000	0.000
01	327	2.5	2.8	14	2	-7	52	0.3	0.00	0.6	0.4			2.9	1.8	1.1		0.03	0.03	0.02	0.05	0.005	0.013
02	350	2.8	2.9	7	2	-10	43	0.0	0.00	0.6	0.1			2.5	1.6	0.9		0.02	0.02	0.02	0.04	0.010	0.021
03	4	3.3	3.5	5	2	-10	41	0.0	0.00	0.6	0.2			2.4	1.5	0.9		0.03	0.03	0.03	0.06	0.005	0.015
04	33	2.8	2.9	7	2	-10	41	0.0	0.00	0.6	0.1			2.9	1.5	1.5		0.03	0.03	0.02	0.04	0.006	0.017
05	333	3.5	3.7	7	2	-12	37	0.0	0.00	0.6	0.1			2.3	1.5	0.8		0.03	0.02	0.01	0.04	0.005	0.018
06	330	4.7	4.8	4	2	-13	33	0.0	0.00	0.5	0.2			2.2	1.4	0.8		0.03	0.03	0.01	0.04	0.004	0.016
07	329	1.4	2.0	20	2	-12	36	0.0	-0.02	0.8	1.0			2.6	1.6	1.0		0.06	0.06	0.03	0.08	0.000	0.006
08	75	1.6	2.4	21	4	-11	34	0.0	0.24	0.9	2.8			3.3	2.0	1.3		0.06	0.06	0.07	0.13	0.000	0.006
09	15	0.2	1.2	21	8	-11	26	-0.3	0.65	0.7	0.8			2.5	1.6	0.9		0.04	0.04	0.02	0.06	0.006	0.018
10	306	5.6	5.8	7	8	-13	21	0.0	1.03	0.7	0.7			2.4	1.5	0.9		0.02	0.02	0.01	0.03	0.010	0.023
11	328	5.8	6.0	6	8	-15	20	0.0	1.23	0.7									0.01	0.01	0.02	0.012	0.026

Appendix B. DENVER HYDROCARBON MEASUREMENTS

Site: 4958 York, Denver, Colorado
Sampling tube 10 m above ground
November 4 - December 14, 1973

Units: ppb carbon atoms

The following abbreviations are used:

ABBREVIATION	HYDROCARBON
2-M Butane	2-Methylbutane
2,2 DMB	2,2-Dimethylbutane
2M 1-Pentene	2-Methyl 1-Pentene
2-MP	2-Methylpentane
3-MP	3-Methylpentane
2,2,3-TMB	2,2,3-Trimethylbutane
Unknown	Unidentified peak eluting near benzene
2-MH	2-Methylhexane
3-MH	3-Methylhexane
M Hexane	Methylcyclohexane
223,233-TMP	2,2,3- and 2,3,3-Trimethylpentanes
2,3,4 TMP	2,3,4-Trimethylpentanes
M Hexene	1-Methylcyclohexene
225-TMHEXENE	2,2,5-Trimethylhexene
Propylbenzene	n-Propylbenzene
Butylbenzene	sec-Butylbenzene

Appendix B. DENVER HYDROCARBONS (Con't)

Denver hydrocarbons in the order of their listing in Appendix B:

Ethane
Ethylene
Acetylene
Propane
Propylene
Freon 12
Isobutane
N-Butane
1-Butene
Freon 22
Isobutylene
2-Butene
Butadiene
Isopentane
1-Pentene
N-Pentane
2-Pentene
2-M Butane
2,2 DMB
2M 1-Pentene
Cyclopentane
2-MP
3-MP
1-Hexene
N-Hexane
2-Hexene
2,2,3-TMB
Cyclohexane
Benzene
UNKNOWN
2-MH
3-MH
1-Heptene
N-Heptane
M Hexane
223,233-TMP
2,3,4 TMP
Toluene
M Hexene
225-TMHEXENE
N-Octane
Ethyl Benzene
M P Xylene
O Xylene
N-Nonene
Propylbenzene
Butylbenzene
N-Decane
N-Undecane
N-Dodecane

	0928	1028	1128	1228	1328	1328	1528	1628
ETHANE		122	132	25	197	27	49	55
ETHYLENE		124	175	17	227	23	7	11
ACETYLENE	169	99	23	12	31	11	9	12
PROPANE	74	121	104	60	131	11	81	115
PROPYLENE	7	98	133	11	186	28	6	4
FREON 12	0	6	0	4	3	11	4	8
ISOBUTANE	27	20	36	34	18	4	52	142
N-BUTANE	79	75	73	60	57	8	89	205
1-BUTENE		26	28	5	32	16	5	8
FREON 22		0	6	0	0	2	0	10
ISOBUTYLENE		34	34	16	54	34	8	12
2-BUTENE		12	7	7	20	1	4	8
BUTADIENE		6	18	0	19	0	7	6
ISOPENTANE		40	42	47	29	24	56	242
1-PENTENE		5	7	0	11	0	0	7
N-PENTANE		38	40	31	34	17	36	145
2-PENTENE		105	152	6	201	5	0	5
2-M BUTANE		16	21	5	26	0	0	10
2,2 DMB		4	4	0	3	0	0	5
2M 1-PENTENE		3	3	0	4	0	0	4
CYCLOPENTANE		4	2	0	4	0	6	17
2-MP		16	25	26	21	14	23	84
3-MP		10	15	20	14	13	16	58
1-HEXENE		6	7	0	18	0	0	46
N-HEXANE		0	136	53	175	51	52	58
2-HEXENE	3	0	12	18	0	13	18	7
2,2,3-TMB	7	0	14	13	18	0	14	32
CYCLOHEXANE	5	20	4	6	10	7	4	11
BENZENE	3	10	8	8	8	2	7	21
UNKNOWN	5	10	22	8	32	0	6	14
2-MH	6	9	16	11	7	8	13	27
3-MH	7	12	18	14	11	7	10	26
1-HEPTENE	10	11	7	9	12	3	8	15
N-HEPTANE	11	0	12	13	15	7	10	24
M HEXANE	8	3	12	10	13	7	11	20
223,233-TMP	4	48	3	4	16	15	15	7
2,3,4 TMP	4	6	3	5	1	0	6	5
TOLUENE	24	0	61	45	148	0	28	52
M HEXENE	5	3	8	11	11	122	7	10
225-TMHEXENE	0	0	5	0	7	3	0	3
N-OCTANE	5	0	9	7	7	0	7	8
ETHYLBENZENE	5	13	13	8	20	3	5	5
M P XYLENE	19	8	37	19	54	0	11	13
O XYLENE	14	0	20	10	26	19	7	10
N-NONANE	7	0	4	0	7	1	6	5
PROPYLBENZENE	0	0	0	0	4	0	0	0
BUTYLBENZENE	6	34	19	12	20	0	5	10
N-DECANE	14	0	8	10	7	7	6	6
N-UNDECANE	5	0	0	9	12	7	7	4
N-DODECANE	0	0	7	4	7	8	5	2

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	1247	1446	1616
ETHANE	43	63	73
ETHYLENE	52	61	78
ACETYLENE	62	69	16
PROPANE	71	220	59
PROPYLENE	16	28	110
FREON 12	4	5	0
ISOBUTANE	56	143	51
N-BUTANE	175	402	0
1-BUTENE	5	7	
FREON 22	0	4	4
ISOBUTYLENE	16	16	155
2-BUTENE	6		0
BUTADIENE	0		0
ISOPENTANE	14	408	110
1-PENTENE	0	5	6
N-PENTANE	0	173	89
2-PENTENE	5	4	33
2-M BUTANE	0	11	9
2,2 DMB	0	12	6
2M 1-PENTENE	12	0	2
CYCLOPENTANE	7	22	12
2-MP	6	162	79
3-MP	34	94	52
1-HEXENE	0	5	6
N-HEXANE	8	99	61
2-HEXENE	4	5	7
2,2,3-TMB	9	55	39
CYCLOHEXANE	4	21	11
BENZENE	6	30	18
UNKNOWN	5	36	26
2-MH	5	60	44
3-MH	12	76	59
1-HEPTENE	10	33	22
N-HEPTANE	4	68	42
M HEXANE	7	50	30
223,233-TMP	27	13	10
2,3,4 TMP	11	13	9
TOLUENE	26	114	73
M HEXENE	9	31	19
225-TMHEXENE	11	5	3
N-OCTANE	31	35	18
ETHYLBENZENE	20	33	16
M P XYLENE	19	84	49
O XYLENE	6	43	24
N-NONANE	24	34	20
PROPYLBENZEN	23	11	10
BUTYLBENZENE	19	31	25
N-DECANE	8	31	18
N-UNDECANE	19	22	18
N-DODECANE	8	0	9

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	0559	1128
ETHANE	158	197
ETHYLENE	246	181
ACETYLENE	212	244
PROPANE	216	802
PROPYLENE	105	121
FREON 12	9	11
ISOBUTANE	204	599
N-BUTANE	423	846
1-BUTENE	10	47
FREON 22	34	58
ISOBUTYLENE	48	61
2-BUTENE	22	48
BUTADIENE	31	30
ISOPENTANE	142	660
1-PENTENE	6	19
N-PENTANE	7	492
2-PENTENE	8	33
2-M BUTANE	5	42
2,2 DMB	27	23
2M 1-PENTENE	86	12
CYCLOPENTANE	55	62
2-MP	19	425
3-MP	155	259
1-HEXENE	0	22
N-HEXANE	55	371
2-HEXENE	14	14
2,2,3-TMB	44	197
CYCLOHEXANE	11	64
BENZENE	29	124
UNKNOWN	34	103
2-MH	18	178
3-MH	16	224
1-HEPTENE	33	58
N-HEPTANE	9	229
M HEXANE	7	191
223,233-TMP	77	34
2,3,4 TMP	48	21
TOLUENE	4	258
M HEXENE	23	101
225-TMHEXENE	36	14
N-OCTANE	126	124
ETHYLBENZENE	71	78
M P XYLENE	35	220
O XYLENE	13	121
N-NONANE	103	96
PROPYLBENZEN	54	35
BUTYLBENZENE	42	96
N-DECANE	16	86
N-UNDECANE	42	67
N-DODECANE	16	29

	1154
ETHANE	66
ETHYLENE	22
ACETYLENE	13
PROPANE	235
PROPYLENE	28
FREON 12	7
ISOBUTANE	746
N-BUTANE	853
1-BUTENE	29
FREON 22	39
ISOBUTYLENE	54
2-BUTENE	37
BUTADIENE	13
ISOPENTANE	16
1-PENTENE	3
N-PENTANE	3
2-PENTENE	4
2-M BUTANE	0
2,2 DMP	5
2M 1-PENTENE	15
CYCLOPENTANE	0
2-MP	0
3-MP	10
1-HEXENE	0
N-HEXANE	6
2-HEXENE	0
2,2,3-TMB	8
CYCLOHEXANE	0
BENZENE	0
UNKNOWN	0
2-MH	0
3-MH	40
1-HEPTENE	30
N-HEPTANE	15
M HEXANE	4
223,233-TMP	2
2,3,4 TMP	0
TOLUENE	5
M HEXENE	12
225-TMHEXENE	2
N-OCTANE	14
ETHYLBENZENE	18
M P XYLENE	5
O XYLENE	5
N-NONANE	19
PROPYLBENZEN	4
BUTYLBENZENE	10
N-DECANE	0
N-UNDECANE	10
N-DODECANE	0

	1637	1737	1837
ETHANE		147	206
ETHYLENE		155	508
ACETYLENE	74	156	530
PROPANE	100	179	269
PROPYLENE	30	71	243
FREON 12	3	8	11
ISOBUTANE	141	221	335
N-BUTANE	312	637	775
1-BUTENE	16	19	51
FREON 22	37	27	82
ISOBUTYLENE	17	13	44
2-BUTENE	16	19	72
BUTADIENE	4	4	1
ISOPENTANE	121	276	999
1-PENTENE	0	14	31
N-PENTANE	7	208	606
2-PENTENE	5	11	46
2-M BUTANE	15	27	118
2,2 DMB	23	11	37
2M 1-PENTENE	73	5	17
CYCLOPENTANE	50	25	89
2-MP	0	204	513
3-MP	31	136	497
1-HEXENE	11	10	44
N-HEXANE	46	143	496
2-HEXENE	12	8	46
2,2,3-TMB	32	109	350
CYCLOHEXANE	10	38	138
BENZENE	32	54	166
UNKNOWN	45	65	273
2-MH	21	109	441
3-MH	32	140	481
1-HEPTENE	56	73	301
N-HEPTANE	11	121	420
M HEXANE	5	102	265
223,233-TMP	94	31	36
2,3,4 TMP	48	30	103
TOLUENE	8	289	488
M HEXENE	52	78	239
225-TMHEXENE	23	8	35
N-OCTANE	82	77	213
ETHYLBENZENE	53	59	76
M P XYLENE	140	203	189
O XYLENE	29	113	571
N-NONANE	73	112	334
PROPYLBENZEN	151	25	73
BUTYLBENZENE	98	127	419
N-DECANE	31	188	205
N-UNDECANE	98	115	120
N-DODECANE	31	31	59

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	1026	1534	1833	1932	2033	2133	2233	2333
ETHANE	90	48	21	0	81	74	66	64
ETHYLENE	36	0	11	0	60	52	102	70
ACETYLENE	74	134	7	4	55	47	114	62
PROPANE	319	5	23	16	80	71	89	53
PROPYLENE	20	30	6	4	20	32	60	37
FREON 12	4	7	0	0	0	0	6	0
ISOBUTANE	182	63	23	8	27	79	102	50
N-BUTANE	316	45	48	17	72	169	237	135
1-BUTENE	8	0	0	0	4	11	21	7
FREON 22	21	0	0	0	9	16	24	15
ISOBUTYLENE	10	173	10	0	6	13	18	8
2-BUTENE	7	0	0	0	2	8	14	8
BUTADIENE	0	25	0	0	6	11	20	12
ISOPENTANE	71	10						
1-PENTENE	0	11						
N-PENTANE	0	19						
2-PENTENE	0	0						
2-M BUTANE	14	0						
2,2 DMB	13	3						
2M 1-PENTENE	34	9						
CYCLOPENTANE	25	6						
2-MP	0	7						
3-MP	21	113						
1-HEXENE	5	3						
N-HEXANE	28	13						
2-HEXENE	8	2						
2,2,3-TMB	15	163						
CYCLOHEXANE	10	4						
BENZENE	26	9						
UNKNOWN	33	5						
2-MH	17	14					71	38
3-MH	20	44	8	4	31	31	71	35
1-HEPTENE	28	14	13	4	34	31	42	24
N-HEPTANE	8	13	23	4	33	37	76	38
M HEXANE	4	4	23	6	32	33	57	27
223,233-TMP	114	0	0	0	9	9	23	12
2,3,4 TMP	30	5	0	0	10	10	23	12
TOLUENE	25	11	16	14	96	87	189	97
M HEXENE	19	0	7	5	29	24	59	37
225-TMHEXENE	46	24	0	0	0	0	5	4
N-OCTANE	26	24	8	0	25	23	51	26
ETHYLBENZENE	58	4	4	0	19	18	45	24
M P XYLENE	17	8	10	12	67	59	144	77
O XYLENE	31	0	5	6	36	35	80	46
N-NONANE	54	53	2	2	41	35	49	31
PROPYLBENZEN	31	7	0	0	12	11	23	13
BUTYLBENZENE	11	25	10	6	0	46	112	59
N-DECANE	0	5	8	5	62	47	52	36
N-UNDECANE	11	0	12	10	36	37	32	21
N-DODECANE	0	0	0	2	8	9	18	9

DENVER HYDROCARBONS NOV 14, 1973

	0033	0133	0233	0333	0433	0533	0633	0733	0913	1013	1113	1213	1313	1413	1513	1613	1813	1913	2013	2113	2213	2313
ETHANE	78	87	211	133	143	165	54	143	66	53	0	0	0	0	6	7	0	11	20	7	14	10
ETHYLENE	94	86	134	66	12	38	91	173	110	52	0	0	0	0	8	6	0	5	7	0	8	2
ACETYLENE	87	79	102	54	23	33	98	187	57	77		0	4	0	12	5	10	9	5	2	10	5
PROPANE	95	92	207	306	315	316	101	140	77	76	0	0	5	0	26	5	15	20	27	11	34	18
PROPYLENE	46	41	42	33	11	16	44	71	39	27	0	0	0	0	0	5	9	0	5	0	5	5
FREON 12	3	2	0	0	0	0	0	7	3	0	0	0	0	0	0	5	0	0	0	0	0	0
ISOBUTANE	65	83	115	125	88	103	79	87	66	67	7	5	4	0	4	11	6	5	6	4	5	4
N-BUTANE	166	196	245	378	195	217	193	239	153	191	21	9	12	19	7	0	23	16	12	5	8	8
1-BUTENE	12	11	10	11	3	6	12	19	9	7	0	1	0	0	0	0	0	0	0	0	0	0
FREON 22	17	19	18	16	5	8	18	28	22	14	0	0	0	0	0	5	0	0	0	0	0	0
ISOBUTYLENE	13	13	14	13	8	7	10	25	7	7	0	0	0	0	5	4	0	10	7	0	5	10
2-BUTENE	8	10	11	12	2	4	7	13	2	4	0	0	0	0	0	0	0	0	0	0	0	1
BUTADIENE	16	14	14	13	4	4	12	29	7	8	0	0	0	0	0	0	0	0	0	0	0	0
ISOPENTANE										145	0	0	0	0	7	11	0	17	12	2	7	8
1-PENTENE										4	0	0	0	0	0	0	0	0	0	0	0	0
N-PENTANE										88	0	0	0	0	4	7	0	7	7	0	2	2
2-PENTENE										6	0	0	0	0	0	0	0	0	0	0	0	0
2-M BUTANE										6	0	0	0	0	0	0	0	0	0	0	0	0
2,2 DMB										6	0	0	0	0	0	0	0	0	0	0	0	0
2M 1-PENTENE										0	0	0	0	0	0	0	0	0	0	0	0	0
CYCLOPENTANE										15	0	0	0	0	0	0	0	0	0	0	0	0
2-MP					17					102	0	0	0	0	2	7	0	6	3	0	3	3
3-MP					9				41	73	0	0	0	0	3	5	0	6	3	3	2	3
1-HEXENE					16				6	2	0	0	0	0	0	0	0	0	0	2	0	0
N-HEXANE					17				63	97	0	0	0	0	3	12	0	8	8	3	4	4
2-HEXENE					0				2	0	0	0	0	0	0	0	0	0	0	0	0	0
2,2,3-TMB					15				41	55	0	0	0	0	0	4	0	4	0	1	4	3
CYCLOHEXANE					8				19	20	0	0	0	0	0	3	0	4	2	0	3	0
BENZENE					13				24	24	0	0	0	0	0	2	0	4	0	0	0	0
UNKNOWN					8				44	32	0	0	0	0	0	4	0	4	3	0	0	0
2-MH	34	48	70	44	22	23	45	92	71	54	0	0	0	0	5	7	0	10	5	5	6	0
3-MH	53	47	87	44	25	26	45	93	79	65	0	0	0	0	5	8	0	7	5	5	5	0
1-HEPTENE	39	30	39	27	9	13	29	52	36	39	0	0	0	0	5	6	4	4	3	3	7	0
N-HEPTANE	17	54	96	43	26	26	41	111	74	59	0	0	0	0	0	6	3	7	6	0	4	6
M HEXANE	18	42	81	43	31	35	38	91	53	42	0	0	0	0	0	5	1	7	5	0	6	5
223,233-TMP	119	16	18	14	6	7	14	35	17	14	0	0	0	0	0	0	0	0	0	0	3	0
2,3,4 TMP	43	16	18	13	4	7	15	27	16	15	0	0	0	0	5	0	0	0	0	3	2	4
TOLUENE	3	121	215	99	81	57	102	227	147	123	0	0	7	11	13	9	11	10	7	21	4	18
M HEXENE	37	52	48	37	16	19	36	75	47	36	0	0	2	0	0	2	3	5	3	0	2	0
225-TMHEXENE	31	9	11	3	0	0	0	7	5	5	0	0	2	0	0	0	0	0	0	0	0	0
N-OCTANE	102	60	51	40	19	18	32	60	36	35	0	0	0	0	0	3	4	4	5	0	2	0
ETHYLBENZENE	55	67	45	25	11	12	24	53	31	25	7	0	0	3	1	3	0	2	0	0	2	0
M P XYLENE	38	217	150	73	40	35	77	174	84	86	18	0	2	10	8	11	8	8	3	0	4	0
O XYLENE	16	98	79	38	22	19	46	96	50	44	6	0	1	5	4	6	5	4	2	0	0	0
N-NONANE	78	49	82	37	19	18	31	64	37	29	6	0	2	7	4	6	5	5	8	0	4	0
PROPYLBENZEN	52	13	23	8	8	4	12	26	11	12	1	0	0	0	0	0	2	0	0	0	0	0
BUTYLBENZENE	32	65	86	50	30	26	61	132	54	47	11	0	5	5	6	7	8	6	6	0	2	0
N-DECANE	15	40	124	42	31	24	41	70	43	32	7	0	5	10	7	10	8	4	0	0	5	0
N-UNDECANE	32	25	73	30	20	21	31	48	21	19	3	0	3	8	4	8	3	3	5	8	0	0
N-DODECANE	15	11	28	12	13	9	20	23	19	11	0	0	0	0	0	3	0	0	0	7	0	0

	0013	0113	0213	0313	0413	0513	0613	0713	0813	0913	1013	1113	1213	1313	1413	1513	1813	1913	2013	2113	2213	2313
ETHANE	13	11	10	13	17	18	48	55	32	28	29	7	11	11	22	13	39	76	109	77	53	29
ETHYLENE	7	0	5	0	0	5	31	71	71	41	59	4	11	0	6	16	68	118	205	130	55	26
ACETYLENE	9	7	3	5	5	8	35	103	97	43	68	5	25	12	7	13	66	140	191	135	51	30
PROPANE	19	11	13	10	19	19	52	55	37	26	27	8	10	8	15	8	58	95	128	144	52	32
PROPYLENE	5	0	0	0	0	3	18	35	35	22	27	0	8	3	4	7	29	58	91	64	31	17
FREON 12	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	6	8	6	0	0
ISOBUTANE	4	8	5	3	11	13	27	29	46	18	34	5	12	7	7	8	82	129	113	135	33	19
N-BUTANE	8	9	7	5	19	23	67	86	106	51	108	13	27	20	14	14	153	283	284	245	81	44
1-BUTENE	0	0	0	0	0	0	4	6	8	5	8	0	0	0	0	0	8	14	10	19	7	0
FREON 22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	23	35	13	0
ISOBUTYLENE	0	10	8	10	8	7	16	20	20	10	18	7	8	6	5	7	24	17	48	23	12	13
2-BUTENE	0	0	0	0	0	0	4	4	5	0	7	0	0	0	0	0	7	7	13	14	5	0
BUTADIENE	0	0	0	0	0	0	5	11	10	5	10	0	0	0	0	0	11	14	31	23	11	0
ISOPENTANE	2	2	6	6	6	24	86	136	181	78	180	16	29	24	24	17	173	240	440	335	128	64
1-PENTENE	0	0	0	0	0	0	0	2	4	0	0	0	0	0	0	0	0	0	10	10	0	0
N-PENTANE	0	2	0	0	0	6	32	67	84	41	73	8	13	8	10	7	106	144	250	190	56	23
2-PENTENE	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	7	10	10	0	0
2-M BUTANE	0	0	0	0	0	0	2	8	6	4	5	0	0	0	0	0	0	16	28	17	4	0
2,2 DMB	0	0	0	0	0	0	5	7	7	4	8	0	0	0	0	0	0	11	18	14	7	4
2M 1-PENTENE	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	4	5	5	4	0
CYCLOPENTANE	0	0	0	0	0	0	7	10	12	5	13	0	2	0	0	0	16	19	35	23	10	4
2-MP	0	0	0	0	2	6	30	78	74	41	79	5	9	8	10	7	76	136	254	158	56	24
3-MP	0	0	0	0	2	4	24	57	50	37	52	5	6	7	6	4	56	90	163	106	42	19
1-HEXENE	0	0	0	0	0	0	0	2	3	0	3	0	7	0	0	0	0	4	7	4	0	0
N-HEXANE	3	6	0	3	4	5	20	51	37	45	41	6	11	6	5	11	36	81	130	85	33	12
2-HEXENE	0	0	0	0	0	0	5	9	6	0	13	0	0	0	0	0	13	12	36	32	13	4
2,2,3-TMB	0	2	0	2	0	4	19	45	38	35	33	3	6	5	5	6	52	64	111	82	37	14
CYCLOHEXANE	0	0	0	3	0	0	8	19	15	9	14	0	3	4	0	3	16	24	42	29	12	8
BENZENE	0	0	0	0	0	0	13	23	21	14	22	2	4	3	3	4	52	35	58	46	21	9
UNKNOWN	7	0	0	0	0	0	8	22	21	13	16	3	3	4	2	5	13	36	45	34	15	8
2-MH	0	4	4	5	0	5	28	53	51	31	52	6	8	8	9	8	68	78	132	98	41	20
3-MH	5	3	0	3	0	6	35	61	59	35	58	5	8	9	9	8	116	91	154	118	49	22
1-HEPTENE	4	2	4	4	4	3	17	39	40	19	21	4	4	7	3	8	56	54	91	70	29	15
N-HEPTANE	2	2	0	0	4	7	34	49	45	31	56	4	6	5	6	8	100	85	118	94	45	14
M HEXANE	3	2	4	4	3	10	36	39	35	30	42	9	7	7	8	12	96	58	91	78	38	15
223,233-TMP	21	0	0	0	0	0	8	15	16	8	11	0	2	2	0	3	8	20	36	28	12	7
2,3,4 TMP	0	0	0	0	4	0	6	15	14	7	8	0	3	3	0	0	12	19	34	26	12	6
TOLUENE	0	3	3	3	18	8	88	119	119	116	75	13	13	8	13	13	68	259	213	153	65	58
M HEXENE	4	0	0	0	0	4	24	41	37	29	24	8	7	8	7	13	31	63	74	70	33	20
225-TMHEXENE	0	0	0	0	0	0	0	4	4	5	4	0	0	0	0	0	0	5	4	9	5	3
N-OCTANE	5	0	0	1	0	0	14	26	29	23	29	10	4	5	4	37	31	49	70	49	20	9
ETHYLBENZENE	0	0	0	0	0	0	8	16	20	11	16	0	2	2	3	7	22	30	49	33	12	4
M P XYLENE	0	0	0	0	0	3	24	54	62	35	51	10	9	11	12	26	57	100	155	104	42	19
O XYLENE	0	0	0	0	0	1	12	30	34	23	29	7	4	6	7	12	29	56	84	56	23	10
N-NONANE	0	0	0	0	0	0	11	22	25	48	59	4	5	24	11	65	29	64	55	39	19	7
PROPYLBENZEN	0	0	0	0	0	0	0	7	11	11	18	7	0	5	4	13	0	18	17	10	4	4
BUTYLBENZENE	0	0	0	0	0	0	18	43	48	38	55	24	7	42	11	16	38	83	110	60	31	12
N-DECANE	0	0	1	0	0	5	14	23		50	82	7	12	7	20	79	24	98	61	40	25	11
N-UNDECANE	0	4	0	0	3	2	13	15	14	27	42	12	12	30	19	35	22	56	40	24	16	4
N-DODECANE	0	0	0	0	0	0	3	5		0	9	0	0	0	0	0	0	15	21	15	10	4

	0013	0113	0213	0313	0413	0513	0613	0713	0813	0913	1013	1113	1213	1313	1413	1513	1613	1713	1813	1913	2013	2112	2213	2313
ETHANE	60	69	55	98	39	91	64	98	88	64	211	84			34	57	29	85	67	92	129	112	154	118
ETHYLENE	24	77	31	36	10	31	49	175	205	114	79	166			14	17	36	104	67	116	257	122	179	137
ACETYLENE	25	74	36	46	13	40	48	179	220	134	100	236			19	19		109	67	125	265	130	173	137
PROPANE	239	98	64	91	36	93	78	109	120	89	834	460			74	98		96	75	109	129	117	437	148
PROPYLENE	25	21	15	19	7	10	25	84	101	54	67	47			9	11		48	32	58	112	57	78	63
FREON 12	0	0	0	0	0	0	0	7	7	0	0	0		0	0	0		3	0	5	3	0	5	6
ISOBUTANE	66	50	45	39	15	32	48	82	157	119	857	217		52	82	103	30	47	52	75	142	75	94	77
N-BUTANE	147	119	93	81	29	68	110	201	319	272	979	514	48	103	156	183	105	130	128	210	385	197	235	201
1-BUTENE	9	6	3	0	0	0	7	9	11	7	56	15	0	5	5	6	6	9	9	16	29	7	21	14
FREON 22	18	15	15	16	0	12	16	19	29	19	53	26	0	0	0	0	0	0	0	0	0	14	0	0
ISOBUTYLENE	10	6	7	8	12	8	11	42	55	36	65	17	13	12	14	20	25	26	23	31	59	32	42	37
2-BUTENE	6	5	6	5	1	6	5	14	22	16	58	10	0	0	4	5	0	0	0	10	20	12	11	8
BUTADIENE	0	5	5	2	0	0	8	30	31	16	17	10	0	0	0	0	11	17	8	19	43	19	26	19
ISOPENTANE	58	106	113	97	22	72	119	288	419	312	999	434			138		140	209	199	329	616	317	373	340
1-PENTENE	0	0	0	0	0	0	0	8	11	6	29	10			0		0	4	0	8	16	7	8	8
N-PENTANE	4	56	53	46	8	32	49	164	254	184	781	269			70		73	119	94	154	388	174	221	179
2-PENTENE	4	0	0	0	0	0	0	6	11	7	23	10			0			6	0	6	18	6	10	9
2-M BUTANE	0	4	3	3	0	0	4	18	30	18	21	15			0			9	6	16	47	17	25	18
2,2 DMB	9	5	6	4	0	0	6	11	16	10	39	16			4			8	7	12	24	12	15	13
2M 1-PENTENE	34	0	0	0	0	0	0	5	6	3	3	5			0			3	0	4	9	5	0	7
CYCLOPENTANE	22	7	11	10	0	7	8	17	32	20	88	31	5	7	10			15	13	23	97	23	27	24
2-MP	0	41	43	45	9	27	38	153	219	155	101	193	19	34	38			101	77	157	371	175	194	189
3-MP	21	29	32	29	9	19	31	105	139	98	484	122	14	23	26			70	51	100	231	119	134	126
1-HEXENE	6	0	0	0	0	0	0	6	8	5	15	8	0	0	0			3	0	6	15	5	6	7
N-HEXANE	23	27	27	26	9	18	19	96	127	111	304	137	25	24	31			56	37	76	214	108	138	115
2-HEXENE	8	5	7	6	4	6	3	11	14	7	13	5	0	0	0			8	8	11	32	24	18	20
2,2,3-TMB	15	29	30	27	7	23	24	79	112	95	365	90	11	20	21	26		52	38	68	157	86	105	96
CYCLOHEXANE	8	10	10	10	0	7	14	36	40	30	234	23	6	5	6	7		18	17	27	69	35	41	37
BENZENE	23	21	16	14	3	11	18	45	63	70	145	54	7	14	14	23		29	24	36	87	45	56	48
UNKNOWN	26	14	10	13	4	18	13	47	55	41	58	38	5	9	8	10		26	16	35	68	36	53	36
2-MH	15	39	33	30	9	24	33	103	138	136	152	96	22	23	22	29		63	45	88	202	97	136	110
3-MH	22	55	37	34	9	27	38	116	167	195	183	118	18	26	25	33		72	53	98	233	113	147	126
1-HEPTENE	22	18	20	20	8	17	27	69	86	63	62	34	9	7	8	11		41	34	64	142	109	89	81
N-HEPTANE	7	53	26	29	4	21	26	93	136	175	171	108	14	22	22	25	29	57	40	79	200	92	125	106
M HEXANE	5	49	26	24	7	22	24	66	93	120	172	84	14	26	25	29	20	42	36	56	167	72	82	90
223,233-TMP	29	9	8	12	0	7	10	25	32	22	26	18	5	5	5	6	9	17	14	23	53	34	31	27
2,3,4 TMP	15	8	8	7	0	5	9	25	31	19	16	14	0	0	2	4	8	14	12	23	50	45	32	30
TOLUENE	3	43	38	52	11	43	47	159	191	148	160	125	24	22	23	28	55	296	72	116	330	177	225	154
M HEXENE	15	22	22	25	7	19	24	52	70	41	87	57	11	14	15	19	23	56	33	54	132	51	85	73
225-TMHEXENE	8	0	0	5	0	0	4	8	11	4	10	7	0	3	4	3	2	4	3	5	25	7	13	9
N-OCTANE	20	14	14	18	3	12	14	53	71	41	84	49	8	13	12	16	15	34	25	41	102	71	68	54
ETHYLBENZENE	8	9	5	9	0	8	10	40	49	29	26	30	9	8	5	9	15	24	18	25	66	31	75	30
M P XYLENE	10	24	26	31	8	23	31	125	164	88	77	80	18	15	19	26	42	79	52	89	214	102	235	96
O XYLENE	0	12	12	16	5	13	17	72	90	48	41	44	8	8	11	14	20	42	29	47	119	55	108	54
N-NONANE	13	20	12	14	0	12	14	95	61	34	50	42	10	10	12	16	12	25	22	34	86	41	59	31
PROPYLBENZEN	10	5	0	0	0	5	4	34	20	8	10	19	0	0	0	0	4	10	6	11	20	14	18	11
BUTYLBENZENE	10	19	17	23	7	14	20	134	104	66	34	47	12	12	14	19	24	59	43	70	146	78	96	73
N-DECANE	4	25	17	18	6	18	16	209	66	47	41	41	10	10	13	23	14	28	29	46	84	49	74	35
N-UNDECANE	10	18	11	12	7	12	14	88	41	23	29	29	10	10	12	12	13	16	22	25	54	30	55	23
N-DODECANE	4	9	4	5	0	4	4	21	21	20	15	19	8	7	0	0	0	7	11	12	29	18	25	14

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	0013	0113	0213	0313	0412	0512	0612	0712	0812	0912	1112	1213	1313	1512	1612	1712	1812	1912	2012	2112	2213	2313
ETHANE	146	108	134	129	127	221	139	81	50	55	14	7	15	15	11	21	21	24	29	0	39	76
ETHYLENE	107	68	68	78	72	95	74	46	38	42	8	0	8	10	1	12	0	24	18	0	31	61
ACETYLENE	96	80	70	84	69	102	86	60	40	43	13	4	13	13	5	11	7	22	18	64	31	62
PROPANE	121	99	128	131	107	200	120	73	52	56	10	8	25	23	16	15	18	23	37	0	41	55
PROPYLENE	47	37	32	40	29	36	34	27	18	22	12	3	6	6	0	0	0	20	10	30	17	29
FREON 12	4	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0
ISOBUTANE	62	47	46	64	45	73	73	78	37	33	5	3	39	15	25	21	9	12	19	0	19	32
N-BUTANE	155	131	107	141	103	158	153	115	65	71	14	11	82	34	47	36	13	31	50	1	54	87
1-BUTENE	10	7	7	12	3	13	14	10	7	6	0	0	5	0	0	0	0	0	0	0	5	6
FREON 22	0	0	0	0	9	24	23	20	18	0	0	0	0	0	0	0	0	0	0	0	0	0
ISOBUTYLENE	28	23	25	31	22	12	17	14	8	18	11	8	14	14	10	12	10	13	7	0	10	22
2-BUTENE	7	6	2	7	8	10	10	6	4	5	0	0	5	0	0	0	0	0	0	0	0	5
BUTADIENE	16	11	8	13	10	17	14	7	4	12	0	0	0	0	0	0	0	0	0	0	0	7
ISOPENTANE	124	187	151	211	156	209	208	156	89	91	18	13	186	26	13	8	11	40	50	112	62	134
1-PENTENE	5	4	2	5	0	6	6	2	0	0	1	0	4	0	0	0	0	0	0	3	0	4
N-PENTANE	15	91	77	109	72	114	114	77	41	41	4	5	95	7	6	5	6	22	25	47	31	72
2-PENTENE	9	0	0	6	0	4	3	3	0	0	0	0	3	0	0	0	0	0	0		0	3
2-M BUTANE	2	9	7	11	6	11	11	7	0	3	0	0	13	0	0	0	0	0	0	0	0	10
2,2 DMB	15	7	8	10	7	8	8	6	2	3	0	0	11	0	0	0	0	0	2		3	6
2M 1-PENTENE	109	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0
CYCLOPENTANE	70	15	12	15	9	16	14	8	7	6	0	0	14	0	0	0	0	0	5	0	4	10
2-MP	4	92	72	104	66	111	95	63	29	32	3	3	105	6	5	3	6	18	17	0	24	69
3-MP	64	67	54	72	41	72	66	46	31	23	3	5	68	4	4	2	4	14	12	0	18	45
1-HEXENE	11	0	0	5	0	3	4	0	0	4	0	0	0	0	0	0	0	0	0		0	3
N-HEXANE	56	61	49	64	40	67	54	43	33	24	6	8	54	13	6	5	3	14	14	0	11	40
2-HEXENE	21	9	11	9	9	10	8	4	2	0	0	0	7	0	0	0	0	0	0		0	0
2,2,3-TMB	34	51	44	56	45	60	50	40	29	18	4	3	46	5	3	0	2	12	12	24	14	35
CYCLOHEXANE	31	21	18	22	15	24	27	13	10	9	0	0	12	2	3	0	2	6	6	9	8	16
BENZENE	66	25	29	35	28	38	38	21	16	11	0	0	30	0	0	0	0	6	7	7	11	17
UNKNOWN	82	20	21	27	17	26	22	17	14	11	0	0	15	4	2	0	0	10	7		11	19
2-MH	49	58	60	73	51	76	85	43	31	23	0	6	58	7	7	0	7	12	14	18	20	44
3-MH	66	65	70	84	62	88	106	49	33	30	3	4	69	8	6	0	6	17	16	31	23	51
1-HEPTENE	49	44	38	49	35	50	49	35	29	18	0	4	28	6	0	0	4	12	11		16	35
N-HEPTANE	20	50	66	67	49	77	103	35	26	20	5	2	52	4	5	6	0	11	12	25	19	41
M HEXANE	23	38	63	53	40	63	106	29	25	21	4	5	41	5	6	6	3	9	11	14	19	28
223,233-TMP	112	14	15	19	15	19	22	12	11	7	2	0	12	3	0	0	0	3	4	10	7	14
2,3,4 TMP	55	17	16	18	16	19	19	12	8	7	4	0	9	0	1	3	5	2	5	13	5	14
TOLUENE	5	82	133	105	65	139	120	65	52	42	20	5	63	13	10	14	16	19	22	53	29	63
M HEXENE	40	40	47	49	22	36	37	19	14	14	0	0	37	5	4	0	0	9	8	21	13	27
225-TMHEXENE	25	0	8	8	5	18	14	5	0	3	0	0	4	0	0	0	0	2	0		0	3
N-OCTANE	82	30	31	36	21	42	37	20	11	13	0	0	29	7	7	7	8	8	8	17	13	25
ETHYLBENZENE	54	14	14	24	16	35	22	12	9	11	0	2	20	3	4	0	0	7	4	0	9	18
M P XYLENE	46	47	52	80	54	115	60	40	27	44	5	3	48	5	5	7	5	18	18	57	26	55
O XYLENE	13	29	29	42	28	56	32	20	14	22	5	2	24	4	0	4	7	7	11	25	14	31
N-NONANE	60	17	25	28	20	42	29	14	13	13	0	2	18	6	2	5	0	6	8	10	11	25
PROPYLBENZEN	48	4	7	8	6	13	8	4	2	0	0	0	6	0	0	0	0	0	0		5	10
BUTYLBENZENE	32	37	43	48	34	52	43	26	24	25	0	2	26	5	26	7	19	13	16	0	24	44
N-DECANE	16	23	34	30	24	52	38	17	20	20	0	4	14	8	8	11	6	7	11	11	16	31
N-UNDECANE	32	13	24	21	13	31	33	13	15	12	5	3	7	5	14	8	11	4	9	11	9	18
N-DODECANE	16	10	13	13	11	18	22	11	0	0	4	0	0	0	0	0	0	0	0	0	0	0

	0012	0112	0212	0312	0412	0512	0612	0712	0812	0912	1013	1113	1213	1313	1413	1513	1613	1713	1813	1913	2013	2113	2213	2313
ETHANE	116	76	84	111	113	127	178	225	137	98	70	69	28	59	83	104	52	36	93	211	145	164	203	94
ETHYLENE	72	53	58	62	67	71	88	85	47	60	29	12	7	10	8	6	12	20	114	133	164	173	263	73
ACETYLENE	77	49	58	65	69	74	78	88	57	64	31	14	5	8	10	10	11	22	129	173	157	176	254	79
PROPANE	100	62	123	101	117	112	185	455	180	110	132	208	47	98	137	189	80	68	89	164	142	146	135	62
PROPYLENE	32	25	28	28	30	26	27	33	22	17	12	15	5	4	3	0	7	15	57	73	91	85	99	37
FREON 12	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	27	24	0
ISOBUTANE	41	27	36	37	47	50	69	225	151	115	229	141	16	27	40	44	25	25	63	148	106	68	103	60
N-BUTANE	107	72	87	101	118	110	148	448	282	256	390	252	35	60	81	98	55	59	158	338	262	252	290	111
1-BUTENE	6	6	6	6	6	6	6	4	5	13	10	6	0	0	0	0	0	6	0	0	0	0	32	0
FREON 22	0	0	0	0	0	0	0	15	0	0	13	0	0	0	0	0	0	0	0	0	51	0	59	0
ISOBUTYLENE	18	14	17	22	22	20	20	24	18	24	16	16	6	14	11	10	10	13	33	41	0	45	0	64
2-BUTENE	6	0	5	5	4	5	4	14	0	17	12	6	0	0	0	0	0	0	0	0	0	8	9	0
BUTADIENE	5	6	6	8	8	7	11	10	6	7	0	0	0	0	0	0	0	7	0	18	62	31	35	0
ISOPENTANE	79	94	128	158	186	146	140	364	121	252	246	132	25	31	40	46	37	53	194	247	0	0	0	0
1-PENTENE	4	2	0	2	4	5	4	7	2	6	5	5	0	0	0	0	0	0	5	7	0	0	0	0
N-PENTANE	9	52	64	84	100	79	79	217	72	139	150	103	16	31	36	50	28	38	94	121	221	301	363	115
2-PENTENE	7	0	0	5	4	3	4	9	0	5	4	0	0	0	0	0	0	0	11	19	0	0	0	0
2-M BUTANE	0	6	9	10	11	9	8	17	6	13	6	3	0	0	0	0	0	4	16	19	0	7	10	0
2,2 DMB	11	3	5	8	8	6	7	12	6	8	9	4	0	0	0	0	0	0						
2M 1-PENTENE	72	0	0	0	3	0	3	2	0	1	0	0	0	0	0	0	0	0						
CYCLOPENTANE	51	10	9	11	12	11	10	22	10	16	14	10	0	6	0	5	3	5	14	12		0	8	0
2-MP	0	46	61	76	91	66	63	125	55	104	72	49	16	2	18	19	14	28	73	90	0	0	9	0
3-MP	39	32	40	53	61	45	46	83	39	70	47	31	5	8	10	14	10	19	44	52	0	0	0	0
1-HEXENE	5	0	4	3	2	2	3	6	2	2	3	3	0	0	0	0	0	0						
N-HEXANE	39	27	45	60	50	65	36	100	32	58	46	41	11	13	17	23	17	22	63	69	0	25	32	0
2-HEXENE	20	0	5	5	0	5	0	9	0	4	0	0	0	13	0	0	0	0						
2,2,3-TMB	20	25	35	42	48	41	36	61	33	60	39	30	7		13	20	11	20	36	49	52	63	0	24
CYCLOHEXANE	18	13	16	21	22	17	16	23	14	20	13	7	3	0	3	5	4	7	26	70	12	0	0	0
BENZENE	48	14	17	20	24	20	19	37	18	26	21	22	6	8	14	18	6	11	14	21	75	86	92	49
UNKNOWN	60	17	18	21	21	22	17	31	18	22	13	10	4	4	4	5	5	9	39	57	24	0	9	0
2-MH	40	34	43	50	58	46	44	60	35	55	34	24	5	8	9	13	10	21	56	72	12	10	11	0
3-MH	46	39	47	57	68	54	51	74	45	67	41	29	9	9	11	15	15	27	45	55	23	22	23	19
1-HEPTENE	34	25	32	40	45	33	34	36	25	37	19	9	6	4	4	5	8	12	15	0	0	0	0	0
N-HEPTANE	15	30	40	47	54	42	44	64	40	52	35	31	6	9	10	16	13	25	42	58	54	65	76	27
M HEXANE	15	21	29	32	36	32	35	48	28	43	30	34	7	12	14	25	15	21	21	28	0	0	0	0
223,233-TMP	92	9	12	14	17	13	13	16	11	15	9	5	0	0	3	2	3	5	16	20	11	14	17	0
2,3,4 TMP	35	10	14	15	18	15	13	14	11	15	5	4	0	0	0	0	0	5	21	27	0	17	0	0
TOLUENE	0	62	65	87	95	78	92	95	65	108	51	27	9	10	11	9	16	32	120	177	51	63	79	25
M HEXENE	30	25	26	37	40	31	36	36	22	27	23	19	2	5	7	9	8	11	37	52	29	35	41	17
225-TMHEXENE	21	0	3	4	5	4	5	5	3	4	3	3	0	0	0	0	0	0						
N-OCTANE	69	18	22	27	33	27	29	36	23	30	21	22	3	4	9	11	8	12	29	42	24	0	0	13
ETHYLBENZENE	40	13	16	20	22	21	22	22	19	20	14	8	3	0	4	4	7	9	28	44	0	18	24	8
M P XYLENE	32	47	53	63	69	57	59	67	47	57	32	19	9	5	5	8	11	22	91	137	39	0	56	15
O XYLENE	12	25	30	34	40	32	35	38	29	31	19	11	5	4	4	5	7	14	42	68	11	0		0
N-NONANE	61	17	22	26	32	31	37	41	31	26	17	17	4	5	4	6	6	11	24	49	8		13	0
PROPYLBENZEN	41	7	8	10	12	8	10	8	8	10	5	0	0	0	0	0	0	0						
BUTYLBENZENE	24	44	44	49	53	42	44	52	41	36	19	14	6	6	7	5	8	18	51	75	19	0	19	0
N-DECANE	7	26	30	36	56	41	61	55	49	31	22	19	2	6	66	6	6	12	21	32	6		5	9
N-UNDECANE	24	16	21	21	30	30	44	38	33	21	15	19	3	4	60	0	0	11	22	26	0	20	21	0
N-DODECANE	7	4	9	7	11	11	18	16	18	8	7	9	0	3	4	0	0	3	7	9	0	14	0	0

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	0013	0113	0213	0313	0413	0513	0613	0713	0913	1013	1113	1213	1313	1413	1913	2013	2113	2213	2313
ETHANE	94	134	115	260	119	125	55	34	53	39			64		77	74	38	55	27
ETHYLENE	67	61	29	24	42	85	54	59	16						6	0	0	0	0
ACETYLENE	64	59	34	27	40	93	53	70	18	9	22		20	11	5	0	0	0	0
PROPANE	96	191	114	748	133	145	71	47	146	41	198	47	192	55	211	235	76	172	46
PROPYLENE	32	30	15	25	20	42	26	34	16	7	29	6	15	8	12	8	0	7	0
FREON 12	0	8	0	0	0	0	0	0	6	3	0	0	0	0	0	0	0	0	0
ISOBUTANE	49	87	63	263	62	66	66	85	194	15	115	14	187	17	167	203	37	120	14
N-BUTANE	121	195	124	617	108	161	145	225	290	37	280	30	302	45	315	298	69	182	25
1-BUTENE	7	13	0	25	13	11	10	9	12	0	16	0	10	0	8	11	0	6	0
FREON 22	0	0	0	0	0	0	19	0	17	0	28	0	0	0	13	14	0	11	0
ISOBUTYLENE	22	28	18	47	19	24	14	28	24	13	19	19	24	11	11	17	10	11	11
2-BUTENE	2	8	0	30	0	8	11	8	12	0	14	0	6	0	5	10	0	5	0
BUTADIENE	8	13	0	6	8	11	8	10	0	0	4	0	6	0	0	5	0	0	0
ISOPENTANE	73	210	101	540	126	194	168	349	247	32	259	49	228	44	218	210			
1-PENTENE	0	2	0	6	0	0	0	7	6	0	6	0	6	0	0	6			
N-PENTANE	5	112	54	298	53	88	88	197	187	13	215	22	172	28	185	161			
2-PENTENE	6	0	0	5	0	0	0	4	3	0	5	0	2	0	0	0			
2-M BUTANE	0	6	4	16	3	6	9	14	8	0	10	0	9	0	0	3			
2,2 DMB	11	6	3	15	6	8	7	12	9	0	9	0	9	0	7	5			
2M 1-PENTENE	66	0	0	4	0	0	0	3	1	0	0	0	0	0	0	0			
CYCLOPENTANE	46	12	7	26	8	13	10	22	18	0	20	7	19	6	19	14			
2-MP	0	71	36	115	38	70	68	142	88	10	77	27	76	20	57	56			
3-MP	46	48	28	71	29	46	49	93	57	7	49	18	50	13	41	36			
1-HEXENE	9	0	0	4	0	0	3	3	4	0	4	0	3	0	0	0			
N-HEXANE	45	47	25	63	26	36	44	79	71	15	67	16	62	14	50	45			
2-HEXENE	14	0	10	10	0	6	5	14	5	0	8	0	3	0	0	0			
2,2,3-TMB	23	40	20	53	22	50	44	68	50	6	39	13	45	14	33	30			
CYCLOHEXANE	16	15	9	12	12	15	19	20	10	2	11	7	10	5	7	5			
BENZENE	40	26	13	40	14	24	27	44	39	5	34	10	35	10	27	27			
UNKNOWN	47	13	9	11	11	26	18	22	16	4	15	7	12	6	6	8			
2-MH	30	40	25	39	26	45	55	80	40	9	34	19	37	16	22	22			
3-MH	37	49	31	45	30	51	68	107	50	8	40	19	46	20	27	27			
1-HEPTENE	22	29	16	22	18	37	28	35	11	2	8	7	10	8	5	3			
N-HEPTANE	12	35	21	37	18	34	50	80	51	6	40	13	44	17	27	25			
M HEXANE	11	36	21	43	23	27	39	63	49	10	39	14	49	18	33	37			
223,233-TMP	60	12	5	10	7	15	12	17	6	4	7	4	6	6	5	4			
2,3,4 TMP	30	12	4	7	5	15	10	12	3	0	3	0	4	3	0	4			
TOLUENE	4	56	28	40	26	59	46	81	36	11	30	14	34	20	15	14			
M HEXENE	23	20	13	31	11	25	21	51	21	4	21	9	23	13	10	10			
225-TMHEXENE	11	0	0	0	5	4	5	5	7	0	5	0	4	3	5	3			
N-OCTANE	45	27	14	23	21	24	19	31	23	7	29	9	21	10	12	11			
ETHYLBENZENE	20	11	7	7	7	13	9	15	14	3	10	0	11	7	4	1			
M P XYLENE	17	45	25	30	21	47	35	57	32	12	25	10	25	16	10	7			
O XYLENE	4	25	11	16	10	24	16	31	17	5	13	6	13	11	5	4			
N-NONANE	28	31	13	17	10	18	14	24	17	2	18	8	18	8	7	7			
PROPYLBENZEN	22	8	2	5	0	6	5	6	5	0	0	0	0	0	0	0			
BUTYLBENZENE	13	30	14	17	16	31	23	34	17	8	13	8	14	14	7	5			
N-DECANE	8	42	19	24	14	18	14	18	13	5	13	12	13	8	6	6			
N-UNDECANE	13	25	13	18	12	13	12	10	11	0	9	8	12	4	4	4			
N-DODECANE	8	12	4	5	4	6	10	8	9	0	7	0	7	4	0	0			

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	0013	0113	0213	0313	0413	0513	0613	0913	1013	1113	1613	1726	1826	1926	2026	2126	2226	2326
ETHANE	42	34	0	24	62	70	38				42		63					
ETHYLENE	0	4	0	0	14	15	7			37	43		147					
ACETYLENE	12	5	0	0	20	17	9		41	65	54	122	157					
PROPANE	67	67	103	33	55	65	54	78			41	47	61					
PROPYLENE	5	0	0	0	12	8	7	23	14	12	19	46	53					
FREON 12	0	0	0	0	0	0	0	0	0	0	0	0	0					
ISOBUTANE	34	14	34	9	14	16	27	68	43	33	21	58	78					
N-BUTANE	64	32	54	14	29	42	46	90	74	60	56	118	142					
1-BUTENE	0	0	0	0	0	0	0	18			7	16	0					
FREON 22	0	0	0	0	0	0	0	0	0	0	0	0	0					
ISOBUTYLENE	0	0	0	0	0	0	0	29	0	0	43	29	63					
2-BUTENE	0	0	0	0	0	0	0	10	0	0	0	6	0					
BUTADIENE	0	0	0	0	0	0	0	0	0	0	0	14	80					
ISOPENTANE	0	0	0	0	0	0	22	104			89	199	0	0	0	0	0	0
1-PENTENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	104	0
N-PENTANE	0	0	0	0	0	0	16	58			55	86	181	122	130	0	0	0
2-PENTENE		0	0	0	20	0	0	0	0	0	4	0	0	0	0	30	0	25
2-M BUTANE		0	17	0	0	0	0	0	0	0	6	7	4	0	0	0	0	0
2,2 DMB								0			4	8						
2M 1-PENTENE								0			0	0						
CYCLOPENTANE	0	0	0	0	0	0	4	6	0	0	11	13	0	0	0	0	0	0
2-MP		0	0	0	4	0	9	38			55	88	9	0	0	6	7	5
3-MP	17	0	0	0	14	11	7	26	15	16	36	64	0	0	0	29	10	25
1-HEXENE								0			0	0						
N-HEXANE	6	0	12	0	0	0	10	22	30	43	36	45	18	13	12	0	24	0
2-HEXENE								4			0	6						
2,2,3-TMB	6	0	0	0	10	0	4	9	16	12	27	52	47	0	0	24	38	11
CYCLOHEXANE	0	0	0	0	0	0	5	0	0	7	13	22	6	0	0	37		17
BENZENE	8	0	0	0	0	0	5	13	6	4	14	30	0	47	36	0	0	0
UNKNOWN	4	0	2	0	0	0	0	15	9	12	16	24	0	0	0	0	0	0
2-MH	5	17	0	7	0	0	0	34	13	17	38	63	8	0	0	0	0	18
3-MH		0	0	0	11	0	0	34	14	16	41	73	15	6	12	34	39	0
1-HEPTENE	0	0	0	0	5	0	0	13	9	8	36	49	0	0	0	0	18	23
N-HEPTANE		0	0	0	0	19	28	26	12	16	27	53	39	29	30	0	32	0
M HEXANE	7	0	0	0	0	0	0	21	11	9	28	44	0	0	0	25	16	15
223,233-TMP	11	0	0	0	0	0	0	7	6	6	12	19	10	9	0	9	10	0
2,3,4 TMP	0	9	0	8	0	0	0	6	5	6	14	19	12	13	0	10	11	12
TOLUENE		0	16	0	22	45	26	40	37	43	46	87	44	36	37	40	50	20
M HEXENE	0	0	0	0	11	0	0	14	19	21	15	30	30	24	19			46
225-TMHEXENE								0			9	0						
N-OCTANE	0	0	0	0	0	8	9	13	17	8	15	32	0	0	17	0	0	13
ETHYLBENZENE	0	0	0	0	11	0	0	14	8	10	9	16	18	9	0	46	0	10
M P XYLENE	0	0	0	0	0	12	0	33	33	31	25	58	0	0	19	0	0	0
O XYLENE		0	0	0	2	0	0	19	12	9	14	32	0	0	5	4	0	0
N-NONANE	0	0	0	0	0	0	0	12	21	5	8	18	8	5	9	0	0	0
PROPYLBENZEN								4			0	5						
BUTYLBENZENE	0	0	0	0	0	0	0	20	15	18	19	46	20	0	0	11	10	10
N-DECANE	0	0	0	0	8	0	20	13	10	0	10	19	5	0	0	0	12	0
N-UNDECANE	0	4	0	0	0	0	0	10	8	0	8	12	0	0	0	0	5	0
N-DODECANE	0	0	0	0	0	0	0	0	0	0	0	7	4	0	0	0	0	0

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	0026	0126	0226	0326	0426	0526	0626	0726	0825	0925	1025	1125	1225	1325	1425	1525	1725	1825	1925	2025	2125	2225	2325
ETHANE										141	293	76	84	31	21	29	32	39	50	36	31	175	31
ETHYLENE										122	128	56	12	16	28	22	78	77	86	66	23	5	5
ACETYLENE										156	112	80	8	29	27	25	84	76	89	63	36	8	7
PROPANE										340	854	119	107	38	21	36	24	42	73	36	47	321	48
PROPYLENE										82	187	24	6	9	20	10	37	36	41	30	12	5	0
FREON 12										0	7	0	0	0	0	0	0	0	0	0	0	0	0
ISOBUTANE										294	821	79	24	28	15	15	28	38	58	34	42	101	16
N-BUTANE										424	1087	148	82	48	31	54	87	110	142	92	93	199	32
1-BUTENE										57	476	0	0	0	4	0	8	10	12	11	3	0	0
FREON 22										0	0	0	0	0	0	0	0	0	0	0	0	0	0
ISOBUTYLENE										85	808	16	12	10	22	11	17	18	20	14	7	0	0
2-BUTENE										37	419	0	0	0	0	0	4	6	6	7	0	0	0
BUTADIENE										18	32	0	0	0	0	0	11	11	8	11	0	0	0
ISOPENTANE							35	181	155	476	1274	194	96	44	47	49	158	161	199	130	102	115	19
1-PENTENE						0			5	14	170	0	0	0	1	1	0	4	0	4	0	0	0
N-PENTANE									79	275	769	72	17	22	22	26	67	86	109	65	56	110	11
2-PENTENE				0	0	0	0	0	0	10	114	0	0	0	0	0	0	5	5	0	0	0	0
2-M BUTANE		0	0	0	4	6	0		5	16	72	0	0	0	1	0	6	9	12	9	3	3	0
2,2 DMB								7	6	13	43	11	3	0	0	0	7	8	11	8	3	2	
2M 1-PENTENE								0	0	3	5	0	0	0	0	0	0	3	3	2	0	0	
CYCLOPENTANE	0	0	0	0	20	0	0		11	27	126	13	6	5	5	4	11	11	16	9	9	11	0
2-MP		4	6	11	0	0	41	73	59	198	652	72	20	14	19	15	73	76	98	57	37	42	8
3-MP	12	27	49	0	0	0	0	52	41	132	509	50	14	10	13	12	53	51	63	38	25	28	7
1-HEXENE								0	3	9	70	0	0	1	0	0	0	4	0	2	0	0	
N-HEXANE	0	0	0	0	0	46	0		39	137	535	45	18	12	13	13	30	45	51	30	23	40	17
2-HEXENE								25	10	24	23	13	0	0	0	0	7	6	7	5	0	0	
2,2,3-TMB	0	0	0	47	43	24	118	42	31	108	296	39	8	10	11	9	40	39	49	28	24	32	9
CYCLOHEXANE	6	20	17	0	0	3	67	18	9	43	78	13	4	6	15	5	19	19	22	13	8	6	6
BENZENE	0	0	0	11	37	0	7	28		74	178	23	0	6	6	4	19	21	29	15	16	26	6
UNKNOWN	0	0	0	0	0	0	0	23		45	113	18	4	7	8	6	16	24	27	18	8	6	0
2-MH	10	0	0	0	0	0	0	55		136	258	46	12	12	27	13	49	51	60	38	21	21	5
3-MH	12	33	33	57	19	11	66	63		178	304	54	12	14	17	16	54	60	72	46	28	25	9
1-HEPTENE	11	0	0		0	13		38		63	87	29	7	11	4	17	47	49	52	32	17	10	0
N-HEPTANE	0	16	0	0	21	20		45		155	309	45	8	9	13	11	43	48	55	34	21	24	0
M HEXANE	4	22	28	30	0	0	39	38		117	272	40	10	10	12	11	32	32	40	22	18	32	0
223,233-TMP	14	7	9	8	0	8	18	15		26	40	16	5	0	12	6	16	16	17	11	5	4	0
2,3,4 TMP	0	9	12	12	0	0	17	14		19	24	13	4	3	20	6	16	18	18	13	5	4	0
TOLUENE		46	48	54	25	28	87	69		156	229	67	14	25	36	36	96	82	127	64	30	17	21
M HEXENE	29				18	18		32		53	108	22	4	8	10	9	38	36	43	21	14	12	0
225-TMHEXENE								7		10	18	4	0	0	0	1	0	3	3	0	0	0	
N-OCTANE	0	0	0	0	0	0	28	38		55	142	20	4	10	8	7	27	30	32	21	11	13	9
ETHYLBENZENE	0	44	41	0	11	5	0	13		31	101	15	3	8	10	9	21	21	25	18	5	3	6
M P XYLENE	0	11	18	0	17	8	83	47	43	89	244	42	8	20	22	23	73	71	88	57	27	12	17
O XYLENE		4	12	0	8	0	0	25	20	49	119	23	4	12	12	14	42	42	49	30	16	7	0
N-NONANE	0	0	0	0	4	7	0	16	8	42	104	18	4	11	7	7	41	23	32	19	12	10	0
PROPYLBENZEN								4	8	8	18	4	0	0	0	0	12	11	12	7	4	0	
BUTYLBENZENE	0	15	6	25	8	0	0	29	24	52	64	20	4	11	13	14	58	54	68	42	22	10	0
N-DECANE	0	0	0	12	12	17	0	12	22	38	77	18	4	8	10	8	85	23	31	24	12	11	0
N-UNDECANE	0	0	0	10	0	10	0	10	10	23	48	14	4	7	7	7	42	14	22	20	13	11	3
N-DODECANE	0	0	0	0	0	7	0		5	13	24	11	7	0	3	4	7	3	8	12	8	4	0

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	0025	0125	0225	0325	0425	0525	0625	0725	0825	0925	1025	1125	1225	1325	1425
ETHANE	70	42	82	59	48	62	66	46	30	23	22	11	11	8	8
ETHYLENE	0	0	17	19	13	18	17	20	8	17	0	0	0	0	4
ACETYLENE	0	5	8	23	16	18	21	18	12	22	21	8	0	0	7
PROPANE	129	46	175	56	49	62	67	46	26	20	14	12	12	9	12
PROPYLENE	0	0	43	10	9	7	7	6	0	6	8	0	3	0	0
FREON 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ISOBUTANE	65	14	202	40	28	25	22	16	17	22	7	5	0	0	8
N-BUTANE	224	34	196	66	55	53	53	44	34	39	24	11	20	12	15
1-BUTENE	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0
FREON 22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ISOBUTYLENE	0	0	0	0	0	0	0	0	0	0	0	0	12	8	5
2-BUTENE	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0
BUTADIENE	0	0	78	0	0	0	0	0	0	0	0	0	0	0	0
ISOPENTANE	158	26	113	51	41	36	44	36	32	32	27	12	10	8	14
1-PENTENE	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0
N-PENTANE	0	20	71	29	21	20	19	20	13	16	13	5	6	0	7
2-PENTENE		0	4	0	0	0	0	0	0	0	0	0	0	0	0
2-M BUTANE		0	7	0	0	0	0	0	0	0	0	0	0	0	0
2,2 DMB												0	0	0	0
2M 1-PENTENE												0	0	0	0
CYCLOPENTANE	20	6	7	4	5	4	3	6	0	3	0	0	0	0	0
2-MP		8	29	19	15	12	16	12	9	11	12	4	5	0	7
3-MP	41	6	18	12	11	8	10	9	7	7	7	3	2	0	6
1-HEXENE												0	0	0	0
N-HEXANE	19	17	29	27	20	17	24	13	15	14	12	4	8	0	5
2-HEXENE												0	0	0	0
2,2,3-TMB	8	4	17	27	13	10	10	7	7	0	6	3	0	0	4
CYCLOHEXANE	8	0	9	0	5	6	10	5	5	0	0	4	2	0	4
BENZENE	9	9	10	7	4	0	4	4	0	0	0	0	0	0	0
UNKNOWN	11	0	11	0	7	8	4	8	8	10	8	0	0	0	3
2-MH	0	0	19	14	13	11	9	12	10	12	0	7	0	0	6
3-MH	7	0	19	15	12	11	11	11	6	11	15	8	0	0	6
1-HEPTENE	13	0	8	7	5	0	4	0	4	0	0	5	0	0	7
N-HEPTANE	0	6	16	14	12	9	11	7	5	8	15	4	5	0	4
M HEXANE	8	7	14	9	8	6	11	6	4	6	0	4	5	0	4
223,233-TMP	9	0	5	6	4	0	3	3	0	4	0	0	2	0	0
2,3,4 TMP	0	0	7	4	4	0	4	5	0	4	0	0	4	0	3
TOLUENE		8	44	26	19	26	19	18	26	30	31	5	17	21	10
M HEXENE	0	0	16	17	15	15	19	12	0	0	0	3	0	0	3
225-TMHEXENE												0	0	0	0
N-OCTANE	0	10	12	4	5	8	10	3	10	0	6	0	7	5	3
ETHYLBENZENE	0	0	9	4	5	6	7	8	6	6	0	0	0	0	2
M P XYLENE	0	17	25	23	17	21	18	21	14	18	35	0	4	4	8
O XYLENE		0	9	8	6	7	7	9	7	7	0	0	5	0	7
N-NONANE	0	0	7	4	4	5	4	5	2	0	0	0	0	0	6
PROPYLBENZEN												0	0	0	0
BUTYLBENZENE	0	0	13	0	0	12	0	0	0	0	8	6	6	0	8
N-DECANE	0	0	0	0	0	0	0	0	0	0	0	5	5	0	6
N-UNDECANE	0	0	0	0	0	0	0	2	4	0	0	3	5	0	3
N-DODECANE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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	1322	1422	1522	1622	1722	1822	1922	2022	2122	2222	2322
ETHANE	15	41	32	32	64	53	60	130	137	98	77
ETHYLENE	6	16	19	34	40	42	55	83	139	90	59
ACETYLENE	15	20	22	41	42	45	63	77	146	88	68
PROPANE	18	96	66	38	65	55	60	355	134	67	54
PROPYLENE	5	14	13	17	20	18	28	48	56	43	32
FREON 12	0	0	0	4	0	0	0	0	4	3	0
ISOBUTANE	9	66	60	28	26	34	33	320	78	45	34
N-BUTANE	26	135	155	75	73	65	85	614	203	113	97
1-BUTENE	0	5	6	7	6	7	6	61	21	0	8
FREON 22	0	10	0	1	0	12	0	81	28	25	21
ISOBUTYLENE	10	6	14	16	17	10	24	92	18	11	11
2-BUTENE	0	4	6	8	5	6	6	66	6	5	11
BUTADIENE	0	0	8	8	11	6	7	16	18	14	13
ISOPENTANE	0	114	156	86	92	108	130	572	267	182	152
1-PENTENE	0	0	0	0	0	0	1	22	5	2	0
N-PENTANE	0	85	114	44	42	50	56	439	142	89	62
2-PENTENE	0	0	0	0	0	0	0	21	9	0	0
2-M BUTANE	0	0	2	0	3	4	5	47	18	9	7
2,2 DMB	0	5	5	0	3	6	5	15	12	8	6
2M 1-PENTENE	0	0	0	0	1	0	0	6	3	2	0
CYCLOPENTANE	0	10	15	7	8	7	8	37	19	11	10
2-MP	0	40	66	35	38	46	53	207	134	86	64
3-MP	0	26	42	24	26	37	38	132	67	61	45
1-HEXENE	0	0	11	6	0	0	0	8	4	2	0
N-HEXANE	0	33	63	28	19	26	25	147	65	50	33
2-HEXENE	0	0	0	2	0	1	17	13	46	21	21
2,2,3-TMB	0	24	38	17	18	22	30	112	68	43	32
CYCLOHEXANE	0	8	10	12	8	11	13	24	28	18	16
BENZENE	0	17	26	13	11	14	19	72	37	29	17
UNKNOWN	0	12	13	13	10	15	15	25	34	26	16
2-MH	0	22	39	33	26	34	39	77	65	60	42
3-MH	0	27	48	33	30	38	44	95	99	65	51
1-HEPTENE	0	12	15	18	21	27	32	36	65	42	37
N-HEPTANE	0	24	37	27	21	26	29	81	72	45	32
M HEXANE	0	23	35	24	19	23	27	82	56	36	29
223,233-TMP	8	5	10	8	11	9	13	17	24	14	13
2,3,4 TMP	0	4	5	5	8	10	10	15	25	15	18
TOLUENE	0	31	52	80	40	36	44	121	119	67	58
M HEXENE	0	13	26	25	20	22	26	55	60	35	30
225-TMHEXENE	0	0	0	11	4	5	3	7	7	5	4
N-OCTANE	10	15	23	24	15	16	18	49	46	26	20
ETHYLBENZENE	6	9	15	21	11	13	12	22	35	18	14
M P XYLENE	4	19	44	52	34	36	42	66	99	59	46
O XYLENE	0	11	23	26	18	22	24	37	58	35	25
N-NONANE	7	18	17	23	17	16	17	40	42	22	18
PROPYLBENZEN	6	0	0	5	5	0	6	8	12	11	6
BUTYLBENZENE	3	12	23	23	29	26	43	48	65	43	36
N-DECANE	0	16	14	22	16	16	19	46	42	24	22
N-UNDECANE	3	9	10	12	10	9	9	24	23	13	11
N-DODECANE	0	0	4	3	4	5	5	3	13	5	7

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	0022	0122	0222	0322	0422	0522	0922	1022	1122	1222	1322	1422	1622	1722	1822	1922	2022	2122	2222
ETHANE	67	62	35	34	39	64	57	102	56	61	76	73	91	32	22	32	39	88	50
ETHYLENE	46	19	14	12	10	17	47	24	36	13	0	6	11	17	17	14	28	52	42
ACETYLENE	46	25	10	19	12	21	59	26	51	11	8	4	13	20	19	15	99	53	42
PROPANE	63	47	29	31	40	71	59	244	70	71	93	77	59	40	19	26	24	79	53
PROPYLENE	20	10	8	8	4	9	23	17	17	7	7	39	8	7	9	8	15	21	22
FREON 12	0	0	0	0	0	0	0	0	4	0	0	20	5	0	0	0	3	3	4
ISOBUTANE	32	17	12	10	27	16	43	283	66	52	49	0	16	15	9	9	19	25	21
N-BUTANE	79	40	27	21	37	34	90	544	118	102	109	78	30	35	26	19	48	63	57
1-BUTENE	4	0	0	0	0	0	6	24	0	0	0	45	3	7	5	3	6	6	10
FREON 22	21	0	0	0	0	0	8	33	0	0	0	0	3	0	0	4	0	0	0
ISOBUTYLENE	10	11	12	10	13	12	18	40	12	0	0	0	35	0	10	8	14	8	10
2-BUTENE	0	0	0	0	5	0	4	28	0	0	0	0	0	0	0	0	0	0	6
BUTADIENE	5	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	5	5
ISOPENTANE	43	50				0	60	299	104		39		36	42	42	36	82	115	82
1-PENTENE	0	0	0	0	0	0	0	0	0		0		0	0	0	0	0	0	0
N-PENTANE	4	17				0	88	6	5	0	0	0	22	14	12	12	37	53	37
2-PENTENE	4	0	0	0	0	0	0	0	0	0	28	12	0	0	0	0	0	3	0
2-M BUTANE	0	0	0	0	0	0	33	0	0	0	0	0	0	0	0	0	0	3	0
2,2 DMB	7	0	0	0	0	0							0	0	0	0	2	4	3
2M 1-PENTENE	41	0	0	0	0	0							0	0	0	0	0	0	0
CYCLOPENTANE	28	4	4	2	2	0	0	0	9	0	0	0	4	0	3	3	4	5	10
2-MP	0	18	11	8	10	15	0	90	36	0	30	0	18	11	14	12	38	45	36
3-MP	19	12	7	6	8	12	40	55	23	9	0	0	13	7	9	11	24	29	25
1-HEXENE	13	0	0	0	0	0							0	1	0	0	1	0	4
N-HEXANE	26	9	9	5	6	8	0	120	49	14	0	7	16	7	13	7	20	25	23
2-HEXENE	12	4	0	0	0	0							0	0	0	0	2	4	2
2,2,3-TMB	15	12	9	0	5	10	0	47	16	0	23	0	10	8	7	7	19	23	17
CYCLOHEXANE	10	8	3	3	4	7	24	12	12	0	0	31	4	2	5	5	9	12	8
BENZENE	35	8	5	5	4	13	12	27	7	0	0	0	7	7	4	5	12	14	11
UNKNOWN	48	6	5	4	2	4	0	25	17	10	0	0	9	5	4	4	11	12	10
2-MH	24	15	10	11	12	22	0	39	25	0	0	0	23	9	10	11	27	31	25
3-MH	41	16	12	12	10	28	0	33	26	0	0	0	15	12	12	11	36	37	28
1-HEPTENE	44	14	10	7	10	10	13	0	0	6	9	0	13	7	9	8	19	33	19
N-HEPTANE	12	11	7	10	10	29	24	29	18	9	0	0	16	7	6	8	22	28	22
M HEXANE	10	13	10	16	12	40	22	27	14	0	0	0	103	10	10	8	21	23	19
223,233-TMP	55	4	3	3	0	5	0	7	9	0	9	0	0	5	4	5	13	9	7
2,3,4 TMP	24	3	3	0	0	0	11	6	0	8	0	0	14	2	4	4	10	10	8
TOLUENE	7	23	13	11	23	33	40	36	40	16	140	520	20	9	14	14	35	45	40
M HEXENE	19	14	7	8	8	14	0	21	16	0	0	0	7	3	9	9	18	22	14
225-TMHEXENE	12	0	1	0	0	0							5	0	2	0	5	5	3
N-OCTANE	36	9	5	4	5	5	39	15	13	0	0	0	7	7	8	8	16	18	13
ETHYLBENZENE	19	4	0	0	0	3	22	11	11	0	0	0	4	4	4	4	10	15	12
M P XYLENE	16	18	10	10	9	16	0	34	39	5	0	0	12	11	14	15	34	43	35
O XYLENE	5	8	7	5	0	7	27	13	0	0	8	0	7	8	8	8	20	25	20
N-NONANE	26	7	5	6	4	8	0	9	0	0	0	14	4	4	5	8	13	14	11
PROPYLBENZEN	20	0	0	0	0	0							0	0	0	5	6	4	4
BUTYLBENZENE	10	12	7	6	7	13	0	34	8	0	0	11	8	5	6	8	25	26	25
N-DECANE	8	11	6	5	8	13	67	0	8	0	0	0	8	5	5	7	14	17	11
N-UNDECANE	10	8	4	5	4	11	81	0	6	0	0	0	3	0	3	4	10	8	7
N-DODECANE	8	3	0	3	0	4	0	0	0	0	0	0	0	0	0	0	3	4	2

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	0006	0106	0206	0306	0406	0506	0606	0706	0806	0906	1006	1333	1433	1533	1633	1733	1833	1933	2033	2133	2233	2333
ETHANE	43	78	97	73	60	84	85	101	102	71	73	31	104	81	64	73	196	144	130	165	125	118
ETHYLENE	25	40	47	24	12	20	24	35	44	29	19		0	7	12	42	83	82	133	133	92	97
ACETYLENE	30	45	55	34	19	25	32	41	51	32	26	10	5	9	14	74	90	87	119	136	89	98
PROPANE	40	92	110	79	71	93	117	118	119	93	106	42	168	148	78	84	205	148	129	134	102	101
PROPYLENE	12	17	22	11	6	9	9	13	18	11	13	4	2	5	4	17	34	37	50	57	35	39
FREON 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	8	0	0
ISOBUTANE	19	29	37	24	22	25	27	39	52	28	39	15	38	35	22	34	63	53	62	67	46	52
N-BUTANE	45	76	98	59	51	57	73	90	141	69	81	37	96	112	50	86	161	145	167	187	121	128
1-BUTENE	5	7	7	3	0	0	4	5	6	5	6	0	0	0	3	6	10	15	18	24	13	14
FREON 22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ISOBUTYLENE	31	11	12	10	8	8	11	11	11	8	8	12	6	10	10	16	24	24	31	29	22	23
2-BUTENE	0	0	4	0	0	0	4	4	6	0	0	0	0	0	0	1	5	7	8	10	5	5
BUTADIENE	8	4	6	0	0	0	4	5	8	0	0	0	0	0	0	5	14	13	18	22	12	16
ISOPENTANE	37	92	121	64	46	48	70	70	95	54	56	24	60	91	30	94	168	164	202	247	150	170
1-PENTENE	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	6	7	5	0
N-PENTANE	5	46	62	31	25	28	40	43	67	38	47	11	40	48	23	66	94	92	125	132	97	94
2-PENTENE	3	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	5	0	7	8	3	4
2-M BUTANE	0	0	5	2	0	0	3	4	5	2	0	0	0	0	0	7	9	9	14	16	9	11
2,2 DMB	3	0	7	3	0	4	4	3	3	3	0	0	0	3	0	5	8	8	8	11	6	8
2M 1-PENTENE	36	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	4	3	0	2
CYCLOPENTANE	23	7	8	5	3	5	5	7	8	7	5	2	4	7	3	8	14	13	17	18	12	13
2-MP	0	40	48	23	14	18	25	33	40	28	25	8	16	23	11	45	87	83	119	135	77	87
3-MP	29	27	33	16	11	13	20	23	31	19	17	6	12	15	9	34	56	54	78	88	52	60
1-HEXENE	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	6	3	2	6	7	3	4
N-HEXANE	18	25	41	14	9	13	19	20	42	22	21	5	18	14	10	55	48	65	72	104	44	71
2-HEXENE	8	2	3	0	0	0	0	0	0	0	0	1	0	0	0	3	6	4	8	10	6	6
2,2,3-TMB	9	23	31	14	8	13	19	25	24	21	18	4	14	12	7	29	42	46	61	62	38	45
CYCLOHEXANE	8	10	12	7	5	7	12	13	10	9	8	3	5	5	8	12	22	16	29	27	18	21
BENZENE	28	12	16	9	6	8	9	12	15	10	12	4	12	10	6	18	25	25	31	35	22	23
UNKNOWN	9	13	14	9	5	7	9	10	13	12	7	3	6	5	3	23	24	25	36	38	24	28
2-MH	9	32	45	20	12	15	19	23	25	21	19	9	9	11	8	37	53	51	70	78	48	56
3-MH	30	33	41	21	14	17	23	30	28	23	21	8	12	13	9	44	61	61	82	94	58	67
1-HEPTENE	32	23	27	14	12	10	15	21	17	17	9	7	5	9	6	25	50	37	53	61	41	43
N-HEPTANE	18	31	32	18	12	14	16	23	26	17	21	6	11	11	9	38	48	46	67	74	44	52
M HEXANE	16	23	24	15	12	13	16	19	19	16	17	10	13	13	9	31	35	37	48	52	30	35
223,233-TMP	92	9	10	9	5	4	7	9	7	7	5	3	0	3	2	13	15	15	18	23	15	17
2,3,4 TMP	4	8	11	10	5	3	5	10	7	5	4	2	0	3	2	11	18	15	19	24	15	17
TOLUENE	5	45	52	29	16	22	32	39	45	31	20	11	11	13	13	58	80	78	118	125	76	94
M HEXENE	34	19	23	11	9	11	14	15	15	16	13	7	7	5	7	29	34	35	46	52	33	38
225-TMHEXENE	7	0	2	0	0	0	0	0	0	0	0	0	0	2	0	3	3	0	4	4	3	0
N-OCTANE	0	15	19	10	7	9	11	12	13	10	13	8	8	5	4	22	30	31	40	42	24	31
ETHYLBENZENE	6	11	14	43	5	8	8	10	11	11	5	4	3	3	4	16	24	26	32	35	22	25
M P XYLENE	8	41	44	129	14	18	24	27	32	25	15	7	5	8	8	48	66	69	95	109	64	76
O XYLENE	8	20	25	53	10	11	13	17	17	17	10	6	4	7	6	34	37	42	56	62	40	43
N-NONANE	1	16	16	11	7	10	11	12	12	11	7	4	2	7	6	23	22	26	33	34	25	29
PROPYLBENZEN	0	5	6	0	0	0	0	0	5	0	0	0	0	0	0	8	12	11	14	14	8	11
BUTYLBENZENE	0	28	34	18	11	14	17	22	22	19	12	5	6	6	6	41	52	54	72	84	49	61
N-DECANE	0	17	18	11	7	11	20	19	16	11	11	5	5	5	5	29	18	25	42	34	22	35
N-UNDECANE	0	10	12	11	5	8	12	13	12	10	7	4	2	3	4	18	13	15	21	20	13	18
N-DODECANE	0	3	5	0	0	0	3	0	2	2	2	0	0	0	0	7	5	8	9	12	8	8

	0033	0133	0233	0917	1017	1117	1217	1317	1417	1517	1617	1717	1817	1917	2017	2117	2217	2317
ETHANE	119	77	105	57	38	31	97	130	115	63	102	81	46					
ETHYLENE	112	40	80	114	102	49	56	14	12	5	23	24	18					
ACETYLENE	107	42	60	151	125	85	76	23	19	11	33	22	18					
PROPANE	109	75	131	55	48	32	158	282	175	135	143	113	20					
PROPYLENE	42	17	23	48	44	20	26	12	6	4	11	12	8					
FREON 12	0	13	0	5	0	0	0	0	0	0	1	0	0					
ISOBUTANE	52	27	61	50	44	28	83	189	44	49	36	29	17					
N-BUTANE	145	73	176	126	124	74	182	362	100	104	80	73	42					
1-BUTENE	14	6	14	16	16	8	11	7	0	4	9	0	0					
FREON 22	0	0	0	0	0	0	0	0	0	0	0	0	0					
ISOBUTYLENE	25	12	18	42	22	12	13	16	0	8	8	12	10					
2-BUTENE	7	0	6	7	5	0	0	11	0	0	0	0	0					
BUTADIENE	17	6	10	16	13	6	8	10	6	4	0	0	0					
ISOPENTANE	107	79	167	172	109	47	65	49	7	7	54	47	26	28	24	20	4	4
1-PENTENE	5	0	0	10	4	0	0	0	0	0	1	0	0	0	0	0	0	0
N-PENTANE	11	47	91	108	71	32	50	46	11	7	14	13	6	5	7	5	0	0
2-PENTENE	8	0	3	22	0	1	0	0	0	0	0	0	0	0	1	0	0	0
2-M BUTANE	2	0	5	13	5	0	0	2	0	0	0	0	0	0	0	0	0	0
2,2 DMB	15	5	6	7	5	0	4	0	0	0	0	0	0	0.	0	0	0	0
2M 1-PENTENE	109	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CYCLOPENTANE	70	6	12	15	11	8	9	7	0	0	6	4	0	0	3	3	0	0
2-MP	5	36	62	124	94	44	62	38	8	3	15	14	6	6	5	5	0	0
3-MP	61	27	46	65	65	29	42	29	5	3	11	8	6	5	5	5	0	0
1-HEXENE	6	2	0	7	4	0	4	0	0	0	0	0	0	0	0	0	0	0
N-HEXANE	53	37	35	97	67	62	54	45	24	10	7	8	8	6	5	8	0	0
2-HEXENE	22	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2,2,3-TMB	27	24	31	60	50	26	41	31	12	7	12	10	6	7	7	0	0	0
CYCLOHEXANE	27	9	12	25	17	10	12	6	4	2	0	0	8	0	0	0	0	0
BENZENE	65	12	16	28	24	13	23	29	9	5	10	9	5	6	4	7	0	0
UNKNOWN	76	10	17	43	28	16	15	8	6	0	3	3	4	0	0	0	0	0
2-MH	51	25	37	88	59	29	36	32	15	13	10	11	5	7	5	5	0	0
3-MH	61	31	39	98	71	34	45	32	11	5	15	11	6	12	6	5	0	0
1-HEPTENE	40	18	24	55	39	18	24	8	6	4	7	8	4	5	4	3	0	0
N-HEPTANE	21	28	30	76	59	27	41	38	14	7	15	11	7	5	5	4	0	0
M HEXANE	21	20	23	56	44	19	33	38	13	9	20	13	11	7	6	7	0	0
223,233-TMP	105	6	14	22	18	8	11	4	5	2	4	4	2	0	0	2	0	0
2,3,4 TMP	37	8	10	21	16	13	12	6	0	3	3	3	0	0	0	3	0	0
TOLUENE	5	41	1	106	105	50	63	38	19	15	13	12	9	4	3	5	4	4
M HEXENE	34	20	16	41	46	18	22	16	8	7	8	8	5	3	1	4	0	0
225-TMHEXENE	26	1	0	7	3	5	0	0	0	0	2	0	0	0	0	0	0	0
N-OCTANE	84	15	15	44	31	18	22	16	8	8	8	4	4	4	3	5	0	0
ETHYLBENZENE	48	11	18	30	27	16	24	9	5	5	4	3	0	0	0	4	0	0
M P XYLENE	30	29	40	93	92	41	54	25	14	13	14	11	10	5	9	8	3	3
O XYLENE	13	18	22	58	52	25	36	14	11	7	7	7	2	0	5	5	0	0
N-NONANE	71	11	14	29	30	23	36	11	12	8	8	6	6	0	2	2	0	0
PROPYLBENZEN	32	0	7	12	12	8	14	8	8	2	0	1	0	0	5	0	0	0
BUTYLBENZENE	23	30	30	62	62	36	37	31	25	8	6	7	5	4	5	5	4	4
N-DECANE	9	16	19	28	32	24	29	17	23	10	6	6	5	4	6	6	0	0
N-UNDECANE	23	9	11	18	20	11	20	11	12	4	5	0	4	0	0	0	2	2
N-DODECANE	9	7	2	10	0	0	5	5	5	0	0	0	0	0	0	0	0	0

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	0017	0117	0217	0317	0417	0517	0617	0717	0817	0917	1017	1117	1317	1417	1517
ETHANE									80	27	21	14	10	11	14
ETHYLENE									184	34	13		6	6	13
ACETYLENE									238	48	12		7	7	16
PROPANE									91	51	20		11	20	12
PROPYLENE									70	16	5		0	5	6
FREON 12									7	0	0	0	0	0	0
ISOBUTANE									65	62	17	27	0	3	12
N-BUTANE									169	130	28	27	13	10	22
1-BUTENE									24	8	0	0	0	0	4
FREON 22									0	0	0	0	0	0	2
ISOBUTYLENE									31	16	5	0	0	0	5
2-BUTENE									12	4	0	0	0	0	6
BUTADIENE									24	5	8	0	0	0	6
ISOPENTANE	5	4	4	4	4	48	94	185	296	66	13	12	10	12	11
1-PENTENE	0	0	0	0	0	0	0	4	10	0	0	0	0	0	0
N-PENTANE	0	0	0	0	0	16	36	100	166	26	7	0	2	4	6
2-PENTENE	0	0	0	0	0	0	0	5	6	0	0	0	0	0	0
2-M BUTANE	0	0	0	0	0	0	4	13	15	0	0	0	0	0	0
2,2 DMB	0	0	0	0	0	0	4	8	13	4	0	0	0	0	0
2M 1-PENTENE	3	0	0	0	0	0	0	5	4	0	0	0	0	0	0
CYCLOPENTANE	3	0	0	0	0	6	12	18	21	7	0	0	0	0	0
2-MP	0	0	0	0	0	14	38	122	155	24	5	6	4	5	6
3-MP	4	0	0	0	0	9	27	86	103	19	3	5	2	3	6
1-HEXENE	0	0	0	0	0	0	0	4	8	0	0	0	0	0	0
N-HEXANE	3	0	0	0	0	7	16	75	81	14	5	4	7	11	11
2-HEXENE	0	0	0	0	0	0	15	17	27	12	0	0	0	0	0
2,2,3-TMB	0	0	0	0	0	11	23	67	77	15	5	4	2	2	5
CYCLOHEXANE	0	0	0	0	0	3	9	22	31	10	0	0	0	0	0
BENZENE	6	0	0	0	0	6	22	36	40	9	3	3	2	0	3
UNKNOWN	5	0	0	0	0	4	10	18	27	8	4	3	3	4	5
2-MH	4	0	0	0	0	9	25	77	89	21	13	5	6	5	5
3-MH	3	0	0	0	0	10	28	91	110	24	5	4	5	6	5
1-HEPTENE	5	0	0	0	0	7	20	50	63	14	4	4	4	3	3
N-HEPTANE	0	0	0	0	0	8	21	73	70	15	4	9	4	5	4
M HEXANE	0	0	0	0	0	14	22	54	60	16	4	22	4	4	15
223,233-TMP	11	0	0	0	0	5	9	21	26	7	3	0	4	0	0
2,3,4 TMP	3	0	0	0	0	4	10	21	26	7	2	0	0	0	0
TOLUENE	0	4	4	4	4	8	46	156	130	22	11	5	5	5	6
M HEXENE	0	0	0	0	0	5	16	42	52	11	11	5	3	3	3
225-TMHEXENE	3	0	0	0	0	0	0	7	8	2	0	0	0	0	0
N-OCTANE	5	0	0	0	0	5	14	47	53	15	4	0	0	3	3
ETHYLBENZENE	0	0	0	0	0	3	11	26	34	7	0	0	0	3	0
M P XYLENE	4	3	3	3	3	9	36	68	103	16	11	7	7	5	9
O XYLENE	0	0	0	0	0	4	19	41	61	10	6	0	5	5	6
N-NONANE	5	0	0	0	0	7	13	30	34	10	8	6	6	5	6
PROPYLBENZEN	5	0	0	0	0	0	8	8	14	2	0	0	0	0	0
BUTYLBENZENE	0	4	4	4	4	10	24	50	77	14	5	6	5	0	7
N-DECANE	0	0	0	0	0	6	16	28	28	11	5	6	5	0	7
N-UNDECANE	0	2	2	2	2	4	11	14	20	10	5	8	4	4	8
N-DODECANE	0	0	0	0	0	0	7	5	14	0	3	0	0	0	0

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	1045	1145	1245	1345	1445	1545	1645	1745	1845	1945	2045	2145	2245	2345
ETHANE	81	32	101	113	176	147	137	116	95	108	116	193	221	288
ETHYLENE	97	23	71	25	13	23	28	42	28	30	46	38	82	56
ACETYLENE	103	26	87	30	15	24	26	40	27	25	48	59	71	56
PROPANE	79	42	229	170	236	266	310	152	135	133	164	443	297	389
PROPYLENE	42	9	26	15	6	9	19	18	15	20	28	28	37	31
FREON 12	0	0	10	0	0	0	10	0	0	0	12	7	14	9
ISOBUTANE	75	22	272	66	77	91	78	61	46	47	66	282	112	109
N-BUTANE	182	75	531	126	181	194	216	136	102	102	158	471	254	275
1-BUTENE												14	0	0
FREON 22												34	8	11
ISOBUTYLENE												17	26	20
2-BUTENE													12	4
BUTADIENE													0	17
ISOPENTANE		50	649	92	174	101	458	152	66	90	138	427	202	175
1-PENTENE		0	4	0	0	0	6	0	0	0	0	6	0	4
N-PENTANE		13	224	38	76	49	283	79	22	44	74	180	108	128
2-PENTENE		0	0	0	0	1	3	0	0	0	0	0	0	2
2-M BUTANE		0	4	0	0	0	12	3	0	2	0	9	6	5
2,2 DMP		3	16	4	5	1	20	7	3	4	0	13	8	7
2M 1-PENTENE		0	0	0	0	0	2	0	0	0	0	0	0	0
CYCLOPENTANE		3	32	8	13	10	38	14	5	11	16	22	19	16
2-MP		12	161	22	44	25	249	62	16	35	41	95	67	65
3-MP		10	103	16	34	18	175	46	13	26	28	66	44	42
1-HEXENE		0	0	0	0	0	4	0	0	0	0	0	0	0
N-HEXANE		9	55	15	18	13	133	36	7	16	18	34	23	33
2-HEXENE		0	4	0	0	0	8	46	0	0	0	0	0	4
2,2,3-TMP		9	81	23	36	21	129	40	15	27	25	48	40	50
CYCLOHEXANE		0	19	7	9	7	35	5	8	7	8	18	9	12
BENZENE		5	47	15	26	16	98	35	5	18	17	37	28	30
UNKNOWN		6	13	4	5	4	13	35	12	0	5	5	7	7
2-MH		11	58	13	21	12	104	22	11	18	23	31	28	36
3-MH		12	76	15	23	16	138	42	12	25	32	34	33	43
1-HEPTENE		9	37	10	8	8	44	17	10	12	21	27	26	29
N-HEPTANE		9	46	12	16	11	71	21	8	12	16	21	20	25
M HEXANE		13	63	19	29	26	110	44	15	30	32	44	37	43
223,233-TMP		5	17	5	8	6	30	10	6	8	10	11	12	12
2,3,4 TMP		4	11	4	5	4	20	7	6	7	8	9	10	10
TOLUENE		14	64	10	15	13	45	16	7	7	17	17	42	21
M HEXENE		7	35	9	13	14	56	14	11	11	15	16	27	16
225-TMHEXENE		0	8	3	4	0	11	0	2	2	4	5	7	5
N-OCTANE		8	33	9	14	19	51	15	10	10	13	20	20	18
ETHYLBENZENE		8	16	3	8	7	16	14	8	5	7	13	9	10
M P XYLENE		29	70	12	26	24	106	34	22	21	37	69	44	45
O XYLENE		13	30	6	10	11	37	13	10	8	20	25	18	22
N-NONANE		7	24	8	16	18	29	17	7	8	11	22	25	18
PROPYLBENZEN		0	7	0	0	10	8	7	9	6	7	7	11	6
BUTYLBENZENE		8	24	8	14	16	37	16	8	12	16	20	24	22
N-DECANE		5	20	10	12	13	16	18	8	13	16	30	22	20
N-UNDECANE		7	18	11	12	13	4	12	8	24	12	20	14	15
N-DODECANE		0	7	5	7	7	4	4	3	13	11	9	5	7

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	0045	0145	0845	0945	1045	1145	1545	1645	1745	1845	1945	2045	2145	2245	2345
ETHANE	319	290	326	112	27	17	594	638	447	470	588	549	335	66	62
ETHYLENE	95	49	228	84	22	17	41	59	42	182	232	288	164	42	40
ACETYLENE	84	49	236	108	27	23	45	69	49	164	220	256	156	43	35
PROPANE	370	375	377	113	23	23	924	744	650	665	713	687	488	92	62
PROPYLENE	39	19	85	37	11	11	17	22	21	75	95	127	78	23	23
FREON 12	9	0	6	1	0	6	0	0	0	8	6	10	7	7	6
ISOBUTANE	106	110	189	87	31	24	255	306	276	258	308	352	247	48	51
N-BUTANE	278	271	469	205	76	82	535	635	523	554	564	598	533	123	100
1-BUTENE	0	0	25	0	0	0	0	6	9	4	4	4	0	0	5
FREON 22	8	12	38	8	0	4	0	4	5	22	23	33	23	4	9
ISOBUTYLENE	23	20	17	23	12	8	0	18	16	37	49	66	42	18	18
2-BUTENE	6	8	24	8	4	0	0	10	0	13	17	22	16	7	5
BUTADIENE	12	20	19	11	0	0	0	14	7	28	26	35	16	7	7
ISOPENTANE	140	214	457	214	83	150	194	316	335	476	593	547	520	154	58
1-PENTENE	0	0	11	4	0	0	0	5	7	11	13	14	14	4	0
N-PENTANE	5	143	266	106	26	36	204	286	274	350	454	446	402	90	42
2-PENTENE	10	0	4	0	0	0	0	6	5	12	17	17	14	0	0
2-M BUTANE	0	5	15	6	0	3	2	4	9	21	36	36	32	6	0
2,2 DMB	19	6	15	9	0	4	11	13	13	20	25	22	21	6	5
2M 1-PENTENE	52	0	4	0	0	0	0	0	2	3	6	7	4	2	0
CYCLOPENTANE	60	18	28	15	4	6	24	36	35	41	58	55	48	13	5
2-MP	3	81	186	80	17	33	117	198	212	287	433	428	366	80	29
3-MP	37	55	130	54	15	23	76	149	140	184	277	275	224	56	21
1-HEXENE	4	2	4	0	0	0	0	11	0	6	11	11	9	0	0
N-HEXANE	49	36	96	33	6	8	114	167	150	163	308	317	235	36	25
2-HEXENE	34	0	10	2	0	0	0	0	57	9	14	55	20	0	0
2,2,3-TMB	34	62	102	43	11	15	86	130	130	148	203	222	178	45	21
CYCLOHEXANE	9	18	32	20	5	11	18	29	33	46	74	70	54	17	11
BENZENE	44	37	60	25	7	9	75	102	89	91	108	114	113	24	13
UNKNOWN	51	10	25	13	3	4	14	20	19	27	49	62	36	12	10
2-MH	45	40	93	48	12	19	46	84	95	130	193	205	183	49	23
3-MH	33	46	115	54	12	19	59	105	113	161	229	252	225	55	26
1-HEPTENE	45	30	69	34	13	26	26	38	57	105	152	148	121	43	21
N-HEPTANE	16	33	73	32	10	9	56	111	96	125	178	212	180	39	17
M HEXANE	17	52	90	41	11	12	89	144	113	131	169	194	172	39	19
223,233-TMP	42	13	29	15	6	9	12	20	24	38	53	57	45	13	8
2,3,4 TMP	31	12	29	13	6	9	10	13	22	38	57	54	44	15	7
TOLUENE	5	31	113	39	8	9	76	122	114	250	299	333	244	69	31
M HEXENE	27	25	54	35	7	10	40	54	48	76	99	112	92	25	12
225-TMHEXENE	13	5	10	4	0	0	5	9	8	11	12	14	10	5	3
N-OCTANE	60	19	46	23	5	8	49	76	55	85	106	123	90	25	13
ETHYLBENZENE	24	14	24	14	3	4	16	33	31	53	73	76	56	14	8
M P XYLENE	24	69	119	64	20	22	47	80	91	181	218	233	181	62	30
O XYLENE	7	31	49	30	8	8	28	47	50	101	120	136	100	32	17
N-NONANE	37	22	40	23	7	7	46	64	44	76	84	103	73	25	13
PROPYLBENZEN	35	5	12	8	5	5	11	14	12	22	30	30	25	10	5
BUTYLBENZENE	23	37	67	34	13	12	34	50	53	102	149	160	114	46	25
N-DECANE	8	31	44	28	13	11	50	56	41	70	76	95	71	32	19
N-UNDECANE	23	25	37	23	10	11	30	45	31	44	55	70	51	29	15
N-DODECANE	8	9	21	12	8	4	16	19	18	23	26	41	26	18	10

DENVER HYDROCARBONS DEC 2, 1973

	0045	0145	0245	0345	0445	0545	0645	0745
ETHANE	21	27	25	18	20	4	4	4
ETHYLENE	0	7	12	8	7	0	0	0
ACETYLENE	8	9	9	5	5	0	0	0
PROPANE	14	25	15	15	8	4	4	4
PROPYLENE	0	5	6	9	9	0	0	0
FREON 12	0	0	0	0	0	0	0	0
ISOBUTANE	8	8	6	6	4	0	0	0
N-BUTANE	17	20	16	13	15	4	4	4
1-BUTENE	0	0	0	0	0	0	0	0
FREON 22	0	0	0	0	0	0	0	0
ISOBUTYLENE	0	0	0	0	0	0	0	0
2-BUTENE	0	0	0	0	0	0	0	0
BUTADIENE	0	0	0	0	0	0	0	0
ISOPENTANE	10	23	20	20	8	0	0	0
1-PENTENE	0	0	0	0	0	0	0	0
N-PENTANE	0	8	8	5	6	0	0	0
2-PENTENE	0	0	0	0	0	0	0	0
2-M BUTANE	0	0	0	0	0	0	0	0
2,2 DMB	3	0	0	0	0	0	0	0
2M 1-PENTENE	9	0	0	0	0	0	0	0
CYCLOPENTANE	7	2	3	3	0	0	0	0
2-MP	0	7	5	8	0	0	0	0
3-MP	11	4	5	6	0	0	0	0
1-HEXENE	0	0	0	0	0	0	0	0
N-HEXANE	4	27	17	21	13	0	0	0
2-HEXENE	5	1	0	0	0	0	0	0
2,2,3-TMB	4	5	0	4	0	0	0	0
CYCLOHEXANE	2	4	0	0	0	0	0	0
BENZENE	8	5	0	3	0	0	0	0
UNKNOWN	8	2	0	0	0	0	0	0
2-MH	7	8	7	9	0	0	0	0
3-MH	4	6	8	7	4	0	0	0
1-HEPTENE	11	5	5	7	0	0	0	0
N-HEPTANE	0	5	4	4	2	0	0	0
M HEXANE	0	6	4	4	3	0	0	0
223,233-TMP	17	2	3	4	0	0	0	0
2,3,4 TMP	4	2	2	3	0	0	0	0
TOLUENE	0	21	10	9	10	4	4	4
M HEXENE	4	7	4	2	2	0	0	0
225-TMHEXENE	4	0	0	2	0	0	0	0
N-OCTANE	12	5	3	3	0	0	0	0
ETHYLBENZENE	6	5	4	3	1	0	0	0
M P XYLENE	12	12	10	10	5	4	4	4
O XYLENE	0	7	5	5	4	0	0	0
N-NONANE	12	10	5	6	5	0	0	0
PROPYLBENZEN	10	0	0	0	0	0	0	0
BUTYLBENZENE	8	13	12	8	8	4	4	4
N-DECANE	3	13	8	10	10	0	0	0
N-UNDECANE	8	10	9	9	9	2	2	2
N-DODECANE	3	4	4	4	4	0	0	0

DENVER HYDROCARBONS DEC 3, 1973

	1630	1730	1830	1930	2030	2130	2230	2330
ETHANE	43	36	41	45	59	63	36	62
ETHYLENE	90	92	86	76	88	56	24	78
ACETYLENE	110	103	92	80	93	64	31	84
PROPANE	45	35	47	48	62	67	40	69
PROPYLENE	39	46	42	36	45	30	16	43
FREON 12	0	0	0	0	0	0	0	0
ISOBUTANE	44	38	46	39	46	35	23	36
N-BUTANE	122	120	117	100	124	90	60	102
1-BUTENE	11	0	11	9	11	8	4	7
FREON 22	6	11	4	3	4	2	3	3
ISOBUTYLENE	28	25	25	22	26	19	11	23
2-BUTENE	7	6	8	6	10	7	0	6
BUTADIENE	12	14	16	12	14	10	5	12
ISOPENTANE	97	162	162	133	173	113	74	122
1-PENTENE	7	6	6	6	6	2	0	4
N-PENTANE	11	103	100	84	108	67	40	70
2-PENTENE	7	5	6	5	7	3	0	2
2-M BUTANE	2	13	11	8	13	6	5	8
2,2 DMB	12	7	6	5	6	4	5	4
2M 1-PENTENE	114	3	2	2	2	2	0	1
CYCLOPENTANE	76	14	13	10	14	8	6	9
2-MP	9	112	104	77	112	58	35	65
3-MP	107	74	69	52	75	40	26	46
1-HEXENE	7	8	11	15	13	13	14	8
N-HEXANE	61	77	71	55	101	52	38	50
2-HEXENE	23	8	7	6	7	5	4	6
2,2,3-TMB	29	54	52	39	57	35	20	36
CYCLOHEXANE	31	23	23	19	22	14	12	18
BENZENE	72	31	29	27	31	20	11	21
UNKNOWN	84	35	34	26	31	19	13	23
2-MH	49	72	67	60	65	41	28	47
3-MH	72	84	79	72	81	48	32	57
1-HEPTENE	51	47	47	35	50	26	20	33
N-HEPTANE	20	67	64	66	75	39	29	45
M HEXANE	18	47	47	59	43	29	24	40
223,233-TMP	188	22	22	19	20	12	8	14
2,3,4 TMP	43	19	19	14	22	11	8	13
TOLUENE	7	123	122	102	120	76	62	104
M HEXENE	45	38	37	31	37	23	14	30
225-TMHEXENE	33	4	5	5	4	3	0	4
N-OCTANE	106	42	43	30	37	26	13	26
ETHYLBENZENE	55	35	27	24	27	21	10	18
M P XYLENE	42	58	66	73	80	57	31	62
O XYLENE	13	52	54	37	43	30	17	34
N-NONANE	67	31	32	28	30	24	12	25
PROPYLBENZEN	48	12	16	10	12	7	4	8
BUTYLBENZENE	25	76	66	53	60	43	28	46
N-DECANE	8	37	35	34	32	29	22	28
N-UNDECANE	25	22	22	29	18	18	13	19
N-DODECANE	8	11	12	11	10	9	7	5

DENVER HYDROCARBONS DEC 4, 1973

	0030	0130	0230	0330	0430	0530	0630	0730	0830	0930	1030	1130	1230	1330	1430	1630
ETHANE	51	55	77	73	104	152	147	21	28	56	32	59	42	35	10	24
ETHYLENE	79	35	35	47	56	138	106	17	46	20	20	66	37	35	6	24
ACETYLENE	89	45	35	52	75	150	110	26	53	24	26	87	64	64	5	14
PROPANE	102	43	71	79	119	214	154	29	38	102	80	73	49	41	11	22
PROPYLENE	36	18	14	21	26	34	43	11	19	12	11	25	17	14	6	18
FREON 12	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	2
ISOBUTANE	43	25	23	45	54	70	66	22	44	55	52	57	33	34	9	12
N-BUTANE	110	65	58	58	122	147	160	38	99	118	131	124	86	86	21	34
1-BUTENE	9	4	4	6	7	11	10	5	5	3	4	5	4	0	0	4
FREON 22	2	0	0	1	3	2	5	0	0	0	0	4	5	0	0	2
ISOBUTYLENE	18	11	11	18	19	19	26	14	16	14	10	14	11	11	6	11
2-BUTENE	8	4	0	7	7	7	7	6	5	2	5	5	0	4	0	2
BUTADIENE	12	5	1	6	10	13	12	0	8	6	0	6	4	4	0	6
ISOPENTANE	82	84	73	118	139	186	229	66	84	137	109	150	100	95	22	30
1-PENTENE	3	0	0	0	5	6	10	0	0	4	0	5	0	0	0	0
N-PENTANE	11	42	36	70	88	116	139	55	59	89	55	89	56	•52	17	19
2-PENTENE	6	0	0	2	5	9	7	0	3	15	0	13	0	0	0	0
2-M BUTANE	3	5	4	7	10	15	15	2	5	7	3	6	3	2	0	2
2,2 DMB	11	4	3	6	9	7	12	3	5	5	5	7	5	5	0	0
2M 1-PENTENE	82	0	0	0	2	3	2	0	0	0	0	0	0	0	0	0
CYCLOPENTANE	55	8	5	7	10	14	17	8	9	8	7	9	7	7	4	6
2-MP	13	35	30	54	75	109	138	29	43	41	34	85	53	43	8	15
3-MP	60	25	21	38	50	73	92	21	32	29	26	57	37	31	6	11
1-HEXENE	6	11	11	10	12	10	16	13	15	23	12	18	16	17	22	20
N-HEXANE	44	25	28	34	62	67	93	31	37	48	33	60	56	37	29	32
2-HEXENE	20	0	0	0	4	9	8	0	3	4	0	0	0	0	0	0
2,2,3-TMB	26	20	17	28	41	54	71	18	27	26	20	41	31	26	7	10
CYCLOHEXANE	27	11	24	13	22	25	32	3	10	10	7	463	17	13	0	5
BENZENE	56	12	10	18	25	34	43	12	16	16	14	23	16	14	4	8
UNKNOWN	70	12	9	14	21	28	37	10	15	12	9	26	17	13	4	8
2-MH	39	27	24	39	48	74	87	20	33	24	24	48	39	37	6	16
3-MH	63	33	27	43	59	93	107	23	39	28	30	56	50	37	7	14
1-HEPTENE	51	24	21	26	30	47	55	11	20	14	12	30	25	23	5	9
N-HEPTANE	17	27	18	36	46	72	90	17	30	23	25	51	42	34	6	10
M HEXANE	14	17	16	30	36	59	68	17	23	20	23	39	39	26	4	11
223,233-TMP	124	9	6	12	14	19	24	9	9	6	7	14	11	10	0	5
2,3,4 TMP	33	8	7	11	12	16	21	5	8	5	4	10	9	8	2	3
TOLUENE	5	43	36	69	88	164	166	29	55	53	27	188	87	58	13	28
M HEXENE	37	18	12	21	29	33	43	14	20	14	12	25	19	16	4	8
225-TMHEXENE	21	2	1	0	7	4	7	0	4	0	3	7	4	3	0	0
N-OCTANE	68	15	12	22	32	37	46	12	16	16	9	29	20	16	5	11
ETHYLBENZENE	37	12	10	14	18	26	30	9	14	12	5	23	15	15	5	9
M P XYLENE	31	37	27	47	60	85	98	24	42	36	21	57	45	40	11	31
O XYLENE	8	19	16	25	31	47	53	12	24	20	11	32	26	25	6	12
N-NONANE	53	13	11	20	25	43	42	11	17	14	8	34	23	23	7	10
PROPYLBENZEN	44	5	11	5	6	12	13	2	6	9	0	8	8	7	0	0
BUTYLBENZENE	22	26	23	38	43	58	71	22	30	22	13	38	28	25	11	16
N-DECANE	10	18	13	29	31	56	49	16	19	25	11	58	30	23	13	14
N-UNDECANE	22	11	9	16	22	33	29	11	12	13	9	23	18	14	11	9
N-DODECANE	10	4	4	7	10	14	13	0	0	2	0	3	7	3	0	2

DENVER HYDROCARBONS DEC 5, 1973

	0901	1045	1152	1252	1352	1452	1552	1701	1801	1901	2001	2101	2201	2301
ETHANE	45	38	7	7	11	41	38	36	32	36	38	45	55	34
ETHYLENE	114	23	6	7	7	13	43	74	55	61	61	48	62	37
ACETYLENE	131	24	8	7	9	16	40	89	63	75	65	54	57	42
PROPANE	73	51	15	20	22	43	40	37	31	40	53	46	66	36
PROPYLENE	45	13	4	3	4	9	27	40	27	26	31	24	37	18
FREON 12	0	0	5	4	4	0	0	0	0	0	0	0	0	0
ISOBUTANE	58	19	14	16	23	26	19	31	24	26	34	33	87	18
N-BUTANE	158	43	53	55	87	76	77	88	69	73	90	82	162	51
1-BUTENE	12	3	0	0	0	2	5	9	7	5	7	6	6	4
FREON 22	3	0	0	0	0	0	0	4	2	3	4	3	3	0
ISOBUTYLENE	26	11	12	8	7	12	14	20	18	19	23	18	20	14
2-BUTENE	11	5	0	5	0	5	5	6	5	6	5	4	12	5
BUTADIENE	17	0	8	0	0	2	8	11	11	8	11	7	10	6
ISOPENTANE	38	34	26	32	54	59	88	94	124	127	140	127	186	91
1-PENTENE	0	0	0	0	0	0	0	4	4	0	1	1	4	0
N-PENTANE	8	24	10	11	20	17	30	54	59	52	64	53	77	34
2-PENTENE	0	0	0	0	0	0	0	2	2	0	2	0	2	0
2-M BUTANE	0	2	0	0	0	0	2	6	6	4	5	5	8	0
2,2 DMB	12	3	0	0	0	0	3	8	7	6	7	6	6	5
2M 1-PENTENE	29	0	0	0	0	0	0	0	0	0	1	0	0	0
CYCLOPENTANE	27	5	4	2	5	3	6	9	8	8	10	8	11	5
2-MP	20	24	6	8	14	17	24	55	58	53	73	53	69	34
3-MP	28	20	5	8	13	11	16	39	40	37	49	40	46	25
1-HEXENE	0	0	35	25	29	21	12	15	15	30	41	31	31	19
N-HEXANE	29	27	32	30	36	52	25	34	38	16	38	14	23	26
2-HEXENE	6	0	0	0	0	0	1	0	3	0	0	0	3	1
2,2,3-TMB	30	17	3	6	14	8	15	34	30	28	37	27	35	19
CYCLOHEXANE	5	5	5	5	4	6	8	41	19	16	16	16	13	11
BENZENE	17	9	2	4	13	8	9	17	17	15	21	16	20	12
UNKNOWN	28	10	2	4	3	3	8	12	16	14	16	12	15	10
2-MH	12	17	4	6	12	10	17	31	42	37	45	39	39	26
3-MH	23	21	3	7	16	12	21	38	46	41	54	46	44	28
1-HEPTENE	62	12	3	5	6	11	22	25	30	29	40	34	31	24
N-HEPTANE	4	16	4	6	14	10	13	30	31	28	38	34	30	21
M HEXANE	11	14	6	8	22	13	18	26	25	25	36	28	28	21
223,233-TMP	58	6	0	3	8	5	8	11	11	14	14	12	11	9
2,3,4 TMP	23	6	0	3	7	3	10	10	11	9	15	12	10	8
TOLUENE	0	35	10	11	15	37	33	73	69	58	66	56	60	43
M HEXENE	16	8	4	7	12	11	12	21	23	20	22	19	22	14
225-TMHEXENE	19	0	0	0	0	0	0	4	3	2	3	0	3	2
N-OCTANE	62	11	7	7	15	19	12	22	20	22	21	16	23	18
ETHYLBENZENE	36	8	4	2	7	11	10	21	15	18	14	13	14	12
M P XYLENE	25	25	12	12	16	31	29	65	54	46	52	45	47	35
O XYLENE	13	12	5	6	8	13	14	35	28	30	26	24	24	22
N-NONANE	67	8	8	11	20	10	12	25	19	17	22	16	18	14
PROPYLBENZEN	43	0	0	0	6	0	4	8	7	6	11	13	4	4
BUTYLBENZENE	25	18	13	12	12	14	20	53	37	31	44	35	35	29
N-DECANE	0	13	13	12	25	11	16	30	23	18	31	23	24	19
N-UNDECANE	25	9	7	7	14	7	10	18	13	14	14	12	12	11
N-DODECANE	0	0	0	0	0	0	0	0	0	0	3	0	0	0

DENVER HYDROCARBONS DEC 6, 1973

	0001	0101	0201	0301	0401	0501	0601	0701	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
ETHANE	41	48	48	45	32	35	29	35	20	21	21	21	17	38	29	74	70	70	45	38	29	41	32
ETHYLENE	32	30	23	22	8	13	13	36	23	31	25	31	29	41	31	252	244	168	83	52	35	28	23
ACETYLENE	38	31	29	26	5	10	15	52	26	31	34	47	36	32	31	269	420	176	86	34	33	29	23
PROPANE	40	52	54	69	41	60	47	53	36	30	24	25	21	41	48	134	213	123	57	56	58	55	60
PROPYLENE	16	15	10	10	6	6	9	18	13	12	10	13	13	29	15	94	99	68	34	26	15	13	11
FREON 12	0	0	0	0	0	0	0	0	0	0	3	5	2	4	4	6	8	7	0	0	0	0	0
ISOBUTANE	18	22	13	15	22	9	11	14	27	20	22	49	46	25	27	99	86	66	34	99	16	18	15
N-BUTANE	45	47	32	32	34	19	28	42	68	60	52	122	125	72	74	273	264	187	102	172	45	48	34
1-BUTENE	2	3	0	0	0	0	0	3	5	0	3	4	5	7	4	21	12	17	0	0	3	3	1
FREON 22	0	2	0	0	0	0	0	1	0	0	0	2	0	2	2	8	0	7	0	0	1	0	0
ISOBUTYLENE	13	14	11	7	11	8	7	11	12	3	11	14	13	16	14	49	65	38	8	23	12	14	11
2-BUTENE	5	4	0	0	2	0	0	5	6	0	4	5	6	5	0	18	19	13	0	0	6	4	4
BUTADIENE	7	6	0	0	0	0	0	8	6	0	4	6	4	8	2	31	28	23	17	0	5	0	0
ISOPENTANE	24	78	40	46	28	20	30	53	47	60	55	83	100	67	66	317	289	253	139	87	62	56	42
1-PENTENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	7	8	4	0	0	0	0
N-PENTANE	0	29	16	18	16	10	14	28	28	24	25	38	36	30	34	191	136	151	64	36	26	30	20
2-PENTENE	3	0	0	0	0	0	0	0	0	0	0	0	2	6	0	8	189	8	6	0	0	1	0
2-M BUTANE	0	0	1	0	0	0	0	0	3	0	0	0	3	2	0	20	22	18	10	7	0	0	0
2,2 DMP	6	5	2	3	0	0	0	0	0		3	3	5	4	0	13		11			3	5	0
2M 1-PENTENE	24	0	0	0	0	0	0	0	0		0	0	1	0	0	5		3			0	0	0
CYCLOPENTANE	18	5	4	4	4	2	4	5	5	0	5	6	5	6	5	26	167	21	7	7	6	6	4
2-MP	21	30	18	19	14	11	15	26	25	19	21	33	40	21	27	196	110	176	54	30	22	27	14
3-MP	20	23	13	16	13	13	14	21	20	14	16	21	25	17	20	127	65	117	35	19	17	19	10
1-HEXENE	0	26	14	12	17	10	14	17	16		1	8	9	6	13	68		9			7	3	4
N-HEXANE	15	25	22	28	29	25	25	26	47	164	16	41	39	42	43	113	293	119	127	.151	44	40	31
2-HEXENE	8	0	0	1	0	0	0	0	0		0	0	0	3	0	8		10			0	3	0
2,2,3-TMB	10	20	12	18	14	15	16	20	19	21	14	19	18	17	17	97	87	91	43	28	16	20	12
CYCLOHEXANE	9	9	11	4	4	3	4	0	7	14	13	10	40	16	10	38	55	32	20	24	6	9	8
BENZENE	20	11	7	9	5	5	7	0	12	4	7	9	8	12	11	51	29	43	12	8	8	11	6
UNKNOWN	22	8	6	4	3	2	3	0	11	8	8	9	9	10	12	36	67	37	27	22	7	8	5
2-MH	18	22	13	14	11	8	11	23	22	12	18	23	22	20	23	113	94	99	40	28	21	20	12
3-MH	16	22	16	18	13	9	12	24	23	15	20	25	25	19	27	137	75	119	34	24	20	24	16
1-HEPTENE	15	16	11	12	6	5	7	18	20	4	13	20	19	11	18	72	0	76	0	0	14	15	11
N-HEPTANE	6	18	11	15	11	10	10	19	17	10	16	18	17	21	27	85	58	97	34	17	15	22	13
M HEXANE	7	19	10	19	13	11	12	16	16	7	13	15	14	29	22	83	38	72	21	11	14	17	9
223,233-TMP	34	6	5	6	3	0	3	9	7	0	7	7	7	7	11	32	23	29	12	16	6	8	6
2,3,4 TMP	11	5	4	5	3	0	2	8	5	4	5	6	10	6	7	32	27	30	14	12	5	7	5
TOLUENE	0	37	27	31	22	20	22	46	48	51	33	46	53	56	47	191	178	192	90	55	36	36	24
M HEXENE	11	12	9	10	7	3	10	14	11	16	11	12	12	12	12	65	62	78	32	21	11	13	10
225-TMHEXENE	9	0	0	0	0	0	2	2	3		5	3	2	2	2	7		8			2	4	2
N-OCTANE	29	12	9	8	9	5	8	13	13	11	9	11	11	11	13	66	35	58	26	20	13	13	7
ETHYLBENZENE	14	9	5	5	4	2	3	10	8	10	18	11	15	13	11	47	49	43	21	15	11	9	7
M P XYLENE	11	25	16	18	9	10	14	34	29	35	26	32	29	27	27	167	172	150	37	53	30	24	20
O XYLENE	2	12	8	13	6	6	7	17	16	15	13	17	18	16	19	98	67	82	34	20	16	14	12
N-NONANE	28	10	8	10	7	5	8	12	22	11	14	16	14	17	16	61	34	46	18	10	12	12	8
PROPYLBENZEN	13	4	4	0	0	0	0	1	11		0	6	5	6	5	25		19			5	6	2
BUTYLBENZENE	9	24	17	17	12	8	12	25	26	17	17	20	22	18	20	138	86	113	44	44	28	24	19
N-DECANE	0	13	14	16	11	10	7	14	38	16	18	25	29	24	24	64	29	49	15	22	22	17	14
N-UNDECANE	9	9	10	8	5	4	5	5	15	8	16	16	11	14	12	44	20	35	14	10	13	8	9
N-DODECANE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	5	11	10	0	0	0	0

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	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1001	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
ETHANE	46	43	46	41	35	6	15	26	30	24	13	20	21	25	31	35	85	104	126	37	63	97	17	10
ETHYLENE	41	46	26	16	8	5	11	46	66	73	19	31	28	30	37	70	179	331	237	170	104	118	10	6
ACETYLENE	38	48	37	19	11	0	11	53	70	48	22	33	31	35	45	67	207	338	277	172	118	108	13	5
PROPANE	63	86	67	68	75	49	42	53	79	37	25	29	34	34	35	75	169	205	137	77	65	120	22	14
PROPYLENE	18	23	13	10	5	0	9	17	23	18	11	18	15	14	17	31	75	120	112	75	47	55	8	5
FREON 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	9	12	7	4	4	0	3
ISOBUTANE	22	22	22	19	11	13	8	12	17	24	21	30	35	40	36	100	174	201	149	88	56	68	25	15
N-BUTANE	51	57	50	42	26	20	19	37	70	76	53	73	97	97	100	239	771	334	410	258	164	193	90	48
1-BUTENE	4	6	3	0	0	0	0	0	0	0	2	6	4	6	4	11	21	33	30	19	11	13	0	0
FREON 22	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	7	7	13	8	4	5	0	0
ISOBUTYLENE	16	19	13	12	11	0	0	0	0	19	13	12	17	13	13	24	42	73	67	43	29	34	11	12
2-BUTENE	5	6	5	0	0	0	0	0	0	0	0	5	5	4	6	13	19	28	23	16	12	12	0	0
BUTADIENE	10	10	4	0	0	0	0	0	11	0	0	7	7	0	5	8	23	40	34	23	14	18	0	0
ISOPENTANE	32	73	58	47	26	15	21	52	93	84	47	59	64	60	43	95		590	732	409	266	305	47	29
1-PENTENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	16	22	8	6	7	0	0
N-PENTANE	0	40	32	22	13	8	6	23	44	37	25	34	35	34	29	64		404	409	217	139	157	19	13
2-PENTENE	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	4	0	22	21	9	5	5	0	0
2-M BUTANE	0	4	4	0	0	0	0	0	20	11	0	2	0	0	0	6	0	43	46	21	13	15	0	0
2,2 DMB	5	5	3	0	0						2	3	2	4	0	5	0	23	25	14	11	13	0	0
2M 1-PENTENE	30	0	1	0	0						0	0	0	0	0	5	0	5	10	4	2	0	0	0
CYCLOPENTANE	27	6	4	3	3	0	0	4	0	6	6	5	6	5	5	11	9	47	44	25	16	19	3	2
2-MP	4	32	26	18	12	8	6	21	33	34	26	40	42	43	47	90	79	379	367	201	136	145	15	4
3-MP	34	24	17	16	10	7	4	15	21	25	18	36	37	30	34	64	62	243	243	133	94	97	10	10
1-HEXENE	0	9	11	11	14						16	0	26	32	15	6	20	12	20	8	11	8	7	0
N-HEXANE	26	26	19	19	25	101	126	113	170	112	21	44	31	45	44	65	96	265	272	141	90	110	43	39
2-HEXENE	11	0	0	0	0						0	0	0	0	0	3	7	64	83	12	41	10	0	0
2,2,3-TMB	15	20	17	11	11	7	0	23	30	26	15	31	25	28	35	52	77	167	171	101	68	86	7	6
CYCLOHEXANE	9	8	7	6	7	0	0	0	14	16	93	167	12	10	11	36	28	57	63	36	28	28	5	9
BENZENE	31	12	12	7	0	0	0	5	7	6	7	11	12	12	15	26	43	88	98	59	39	41	5	4
UNKNOWN	36	9	6	4	0	0	7	12	21	12	5	11	11	11	14	19	54	80	96	44	33	30	6	2
2-MH	23	27	26	15	8	8	5	18	29	20	16	24	23	26	32	49	112	210	213	125	82	88	11	12
3-MH	36	30	32	15	8	13	5	16	29	20	19	25	27	30	40	60	140	239	265	149	96	100	14	10
1-HEPTENE	35	18	15	15	5	0	0	0	0	0	15	19	24	19	22	31	68	121	148	87	54	65	11	9
N-HEPTANE	10	24	28	13	8	5	5	13	28	15	14	29	23	29	34	56	111	200	199	119	76	83	14	6
M HEXANE	10	23	30	12	7	5	8	9	15	12	13	21	19	25	24	39	84	143	146	94	61	64	11	7
223,233-TMP	65	9	9	6	2	0	0	6	16	6	7	10	11	8	9	16	32	51	53	35	21	26	5	4
2,3,4 TMP	16	8	5	8	0	0	0	7	15	9	6	8	8	8	8	13	31	41	54	30	20	25	4	3
TOLUENE	0	63	57	29	18	72	19	31	55	49	32	75	50	100	76	135	259	359	334	224	152	130	23	15
M HEXENE	20	18	13	8	5	0	0	15	24	18	8	15	15	21	21	32	70	114	137	98	66	66	7	4
225-TMHEXENE	11	2	0	0	0						0	0	3	4	5	5	21	12	13	11	8	5	0	0
N-OCTANE	36	19	13	9	5	0	10	10	17	14	10	16	15	29	23	35	84	130	126	68	43	46	15	5
ETHYLBENZENE	20	13	9	5	4	0	6	11	16	15	10	11	15	19	19	30	75	115	96	47	30	27	9	4
M P XYLENE	17	41	30	18	10	12	14	41	58	54	25	30	32	48	51	96	236	372	311	158	98	95	20	16
O XYLENE	7	24	17	10	6	6	0	13	22	28	16	18	19	25	28	49	124	194	164	83	48	49	10	7
N-NONANE	29	19	16	8	5	0	0	9	15	17	11	19	22	34	35	36	114	132	121	55	40	35	11	10
PROPYLBENZEN	22	11	7	2	0						6	12	8	10	11	13	25	43	31	14	11	7	0	0
BUTYLBENZENE	8	32	25	16	10	0	12	16	22	25	20	36	35	46	41	60	148	211	181	97	61	61	23	16
N-DECANE	0	22	19	14	10	0	0	9	14	18	19	42	32	36	44	56	149	128	114	54	41	34	22	16
N-UNDECANE	8	19	15	11	8	0	0	6	15	13	13	35	41	19	23	33	87	79	59	32	30	18	13	10
N-DODECANE	0	0	0	0	0	0	0	0	0	3	5	11	11	10	11	13	35	34	31	16	15	12	10	8

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	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1300	1547	1647	1747	1847	1947	2047	2147	2247	2347
ETHANE	13	21	6	11	39	36	17	59	52	42	21	10	22	10	20	29	66	39	70	45	29
ETHYLENE	6	10	0	0	19	11	0	21	31	35	26	6	0	12	12	20	67	21	7	14	6
ACETYLENE	3	9	0	0	31	11	5	37	58	43	35	8	5	14	19	28	66	19	9	16	6
PROPANE	15	16	8	11	32	43	21	65	78	48	26	7	25	11	18	24	44	33	181	49	27
PROPYLENE	0	6	0	0	7	7	0	31	15	16	13	0	0	6	13	14	9	12	8	8	0
FREON 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ISOBUTANE	16	9	5	7	15	12	40	54	55	51	24	14	0	7	14	13	41	14	17	6	0
N-BUTANE	31	23	11	11	31	27	50	110	107	140	66	24	31	30	40	43	106	44	73	31	39
1-BUTENE	0	0	0	0	0	0	0	0	6	5	6	0	0	0	0	0	0	0	0	0	0
FREON 22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ISOBUTYLENE	8	8	7	12	11	12	11	0	19	17	12	0	0	0	0	0	0	0	0	4	0
2-BUTENE	0	0	0	0	0	0	4	0	5	7	0	0	0	0	0	0	0	0	0	0	0
BUTADIENE	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
ISOPENTANE	6	24	7	10						91	67	17	17	34	50	50	138	61	55	30	15
1-PENTENE	0	0	0	0						0	0	0	0	0	0	0	0	0	0	0	0
N-PENTANE	0	8	6	5						37	34	4	7	12	16	20	68	21	17	15	6
2-PENTENE	0	0	0	0						0	0	0	0	0	0	0	0	0	0	0	0
2-M BUTANE	0	0	0	0					4	0	5	0	0	0	0	0	34	0	0	0	0
2,2 DMB	0	0	0	0					5	3	3										
2M 1-PENTENE	6	0	0	0					0	0	0										
CYCLOPENTANE	5	0	0	0					7	5	3	0	0	0	3	3	9	0	0	0	0
2-MP	0	7	3	5					35	34	29	4	4	9	16	18	51	22	16	11	9
3-MP	26	5	0	3					27	22	20	0	0	6	8	11	34	13	8	5	0
1-HEXENE	0	0	0	0					7	0	3										
N-HEXANE	4	22	25	14					32	18	35	0	100	0	134	125	342	274	216	0	205
2-HEXENE	0	1	0	0					0	0	0										
2,2,3-TMB	3	5	0	3					20	17	17	0	0	0	28	29	52	52	23	0	0
CYCLOHEXANE	2	4	0	3					7	7	7	0	0	0	0	30	34	44	0	0	0
BENZENE	6	0	0	0					12	11	8	0	0	0	0	0	13	15	0	0	0
UNKNOWN	6	0	0	0					8	9	11	0	0	0	0	0	29	20	5	0	0
2-MH	6	5	2	4					24	25	21	7	4	6	13	14	41	26	11	8	0
3-MH	4	8	3	5					29	25	24	5	6	6	12	12	30	19	9	6	0
1-HEPTENE	8	7	4	5					12	17	14	0	0	0	0	0	0	0	0	0	0
N-HEPTANE	2	5	3	3					21	17	13	0	0	0	11	8	25	8	5	0	0
M HEXANE	3	7	5	4					21	17	14	10	8	6	7	7	17	9	14	15	34
223,233-TMP	9	2	0	0					6	7	5	0	0	5	4	5	11	5	3	4	0
2,3,4 TMP	7	2	0	0					4	8	4	0	0	4	7	6	15	6	7	7	0
TOLUENE	0	12	7	6					31	58	27	18	10	19	63	48	81	42	19	134	50
M HEXENE	4	7	3	3					16	20	14	12	0	0	0	0	30	16	12	0	0
225-TMHEXENE	3	0	0	0					3	0	2										
N-OCTANE	11	7	4	4					13	14	15	23	0	6	8	6	26	120	4	6	0
ETHYLBENZENE	7	4	0	1					8	12	7	8	0	10	7	8	18	11	0	13	0
M P XYLENE	10	15	9	10					26	48	26	22	25	27	29	34	74	47	40	32	38
O XYLENE	0	7	5	5					13	23	11	8	0	0	9	18	30	14	0	12	0
N-NONANE	11	7	8	4					12	12	10	14	0	7	5	0	24	9	0	8	0
PROPYLBENZEN	14	0	0	0					0	0	0										
BUTYLBENZENE	10	11	11	8					17	22	19	14	18	21	16	15	29	19	0	0	0
N-DECANE	8	10	11	7					16	13	10	13	0	0	0	0	0	0	0	0	0
N-UNDECANE	10	8	8	8					10	10	9	5	0	0	0	0	0	0	0	0	0
N-DODECANE	8	4	4	0					5	8	4	0	0	0	0	0	0	0	0	0	0

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	0047	0147	0247	0347	0447	0856	0956	1056	1156	1256	1356	1456	1556	1656	1756	1856	1956	2056	2156	2256	2356
ETHANE	24	28	31	18	14	22	21	21	22	17	17	17	17	28	36	57	52	56	53	64	60
ETHYLENE	3	15	5	0	0	13	0		4	1	5	8	7	23	26	42	32	30	41	49	38
ACETYLENE	10	79	9	18	0	11	2		4	7	10	11	11	25	27	47	33	31	41	48	43
PROPANE	23	26	31	26	20	26	23		25	21	23	19	20	27	35	54	49	49	44	53	45
PROPYLENE	0	0	0	0	0	8	2	0	6	4	5	4	4	13	15	20	15	14	16	24	18
FREON 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ISOBUTANE	12	0	4	5	3	10	6	8	8	9	10	9	7	13	17	25	21	17	19	21	20
N-BUTANE	37	35	26	15	8	22	12	15	19	23	28	22	21	41	40	64	51	43	56	58	51
1-BUTENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	5	3	3	4
FREON 22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	4	0
ISOBUTYLENE	0	0	0	11	10	8	11	5	6	6	8	6	8	12	12	19	11	14	16	19	12
2-BUTENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	4	0	5	4
BUTADIENE	0	0	0	0	0	1	0	0	0	0	0	0	0	6	7	7	5	0	6	10	5
ISOPENTANE	7	13	13	11	8		13	17	65	41	34	25	28	50	47	83	65	60	65	91	73
1-PENTENE	0	0	0	0	0		0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
N-PENTANE	0	6	5	4	2		5	5	24	20	12	11	13	23	30	40	31	30	32	41	31
2-PENTENE		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2-M BUTANE		0	0	0	0		0	0	0	0	0	0	0	0	0	5	0	0	3	3	2
2,2 DMB				0	0		0	0	0	0	0	0	0	0	0	4	4	4	4	5	5
2M 1-PENTENE				0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CYCLOPENTANE	4	0	0	0	0	3	0	0	3	0	3	3	0	7	5	8	5	7	5	6	6
2-MP		6	3	3	0	8	2	4	12	10	11	6	11	18	24	35	31	24	27	33	29
3-MP	236	0	0	0	0	9	3	3	10	7	9	7	12	13	24	27	23	19	21	27	22
1-HEXENE				0	0	0	0	0	0	7	0	0	0	8	0	4	5	0	2	0	1
N-HEXANE	0	118	193	27	15	29	21	20	26	59	41	28	34	29	38	19	17	12	14	16	13
2-HEXENE				0	0	3	2	0	6	4	0	0	0	0	0	3	0	0	0	0	0
2,2,3-TMB	0	0	0	0	0	7	0	0	0	8	6	5	9	12	12	23	18	18	17	20	18
CYCLOHEXANE	0	0	13	0	0	5	0	0	5	0	4	2	4	6	8	8	8	8	7	11	9
BENZENE	15	0	0	0	0	4	0	0	3	5	5	2	5	7	7	11	10	8	9	12	9
UNKNOWN	0	3	0	0	0	10	0	0	2	7	5	3	2	6	7	10	10	6	8	10	8
2-MH	0	0	0	3	2	6	3	4	7	8	7	9	8	14	16	30	24	19	20	25	21
3-MH	0	0	0	2	0	7	4	4	8	11	8	10	10	17	17	30	23	20	24	28	25
1-HEPTENE	31	0	0	5	3	4	5	3	6	5	10	7	9	12	12	24	18	22	23	25	20
N-HEPTANE	0	0	0	0	0	4	3	2	6	15	7	8	10	12	18	24	15	16	16	20	18
M HEXANE	0	11	24	0	6	8	6	4	7	28	8	8	12	13	14	22	16	16	16	20	19
223,233-TMP	53	0	0	0	0	3	0	0	3	5	2	4	4	5	7	10	6	6	7	9	9
2,3,4 TMP	0	0	0	4	0	0	0	0	3	2	3	3	4	4	4	9	5	8	8	10	9
TOLUENE		17	24	20	10	29	7	6	7	28	23	17	34	29	33	61	39	45	42	49	43
M HEXENE	0	0	0	0	0	9	3	0	4	20	7	5	10	16	13	25	16	18	19	24	20
225-TMHEXENE				0	0	2	0	0	0	5	2	0	0	0	0	0	0	3	0	2	3
N-OCTANE	21	3	6	5	5	9	3	7	5	27	8	9	11	11	12	19	15	15	14	16	15
ETHYLBENZENE	0	0	0	0	0	9	0	0	3	5	8	7	8	9	9	14	13	11	12	12	11
M P XYLENE	0	13	18	8	5	23	5	9	10	23	14	16	23	25	26	46	32	34	35	41	35
O XYLENE		0	0	2	2	12	0	2	6	12	8	8	13	14	14	24	17	18	18	28	18
N-NONANE	0	0	0	5	5	8	5	4	8	26	8	14	12	12	12	19	12	13	13	16	14
PROPYLBENZEN				0	0	0	0	0	0	0	0	0	0	0	4	7	5	6	6	7	4
BUTYLBENZENE	0	0	0	8	8	14	7	8	8	19	12	19	22	25	23	35	28	31	30	35	29
N-DECANE	0	0	0	7	8	12	7	5	12	18	8	20	13	14	16	23	19	17	17	22	19
N-UNDECANE	0	0	0	5	4	8	2	3	7	8	7	8	8	9	10	12	10	9	9	11	10
N-DODECANE	0	0	0	2	1	4	3	3	3	5	3	0	0	0	0	5	5	5	3	3	0

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	0056	0156	0256	0356	0456	0556	0656	0755	0856	0956	1055	1157	1306	1406	1506	1606	1706	1806	1906	2006	2106	2206	2306
ETHANE	42	74	36	24	43	52	85	50	34	32	32	38	45	32	87	10	16	38	38	41	48	39	42
ETHYLENE	17	32	5	0	10	26	127	78	71	35	60	50	70	64	219	0	13	62	39	48	43	40	35
ACETYLENE	20	33	7	4	14	32	106	102	95	44	73	56	80	82	273	6	29	48	38	44	37	40	37
PROPANE	36	63	29	23	43	40	68	38	42	24	42	24	47	39	82	9	11	24	30	27	27	34	25
PROPYLENE	9	13	0	0	5	12	56	35	31	18	28	25	31	29	80	0	7	24	20	18	16	22	18
FREON 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0
ISOBUTANE	15	23	10	8	23	19	44	37	47	28	47	40	53	43	91	8	22	28	32	22	16	27	22
N-BUTANE	35	56	19	12	39	44	116	93	113	61	123	87	146	144	259	14	23	79	67	60	46	63	52
1-BUTENE	0	4	0	0	0	0	10	7	9	4	7	0	8	0	0	0	0	0	0	0	0	4	0
FREON 22	0	0	0	0	0	0	4	5	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0
ISOBUTYLENE	12	13	6	7	11	14	31	26	19	13	18	16	23	22	34	0	0	17	0	0	0	12	16
2-BUTENE	0	4	0	0	0	0	12	8	10	4	8	0	5	0	0	0	0	0	0	0	0	0	0
BUTADIENE	5	0	0	0	0	4	19	12	11	7	6	0	7	0	18	0	0	13	0	0	0	7	0
ISOPENTANE	20	53	26	20	56	64	174	157	168	101	223	103	211	143	388	39	22	0	0	0	0	89	92
1-PENTENE	1	0	0	0	0	0	5	4	0	0	4	0	4	0	0	0	0	0	0	0	0	0	0
N-PENTANE	0	20	13	7	22	29	92	79	83	49	116	46	109	75	169	16	10	0	0	0	34	40	41
2-PENTENE	0	0	0	0	0	0	0	4	3	0	6	0	3	3	18	0	0	0	0	0	0	0	0
2-M BUTANE	0	0	0	0	0	0	9	9	7	3	8	0	6	4	21	0	0	0	0	0	0	3	0
2,2 DMB	7	0	0	0	0	0	9	8	9	5	6		8									6	5
2M 1-PENTENE	19	0	0	0	0	0	0	0	0	0	0		0									0	0
CYCLOPENTANE	16	0	3	0	0	6	12	10	11	6	13	12	13	11	17	0	0	0	7	4	4	5	6
2-MP	4	18	16	9	18	25	75	78	88	43	89	38	109	66	133	8	17	39	34	27	32	37	40
3-MP	7	16	21	8	14	20	57	53	60	31	70	26	77	44	80	0	0	25	21	16	25	26	36
1-HEXENE	0	0	0	0	0	0	0	0	0	1	0		3									0	0
N-HEXANE	8	10	30	10	11	11	39	40	27	23	82	93	72	206		196	113	171	176	216	185	15	33
2-HEXENE	4	0	0	0	0	0	5	5	0	0	9		0									0	0
2,2,3-TMB	4	14	22	10	13	14	44	47	44	25	66	21	53	49	72	0	0	45	41	39	49	19	34
CYCLOHEXANE	3	6	0	0	3	9	17	17	155	36	17	10	35	32		36	6	32	26	43	32	17	11
BENZENE	12	7	12	4	6	10	24	22	24	14	26	8	24	18	29	0	9	9	6	8	11	10	14
UNKNOWN	13	5	3	3	0	8	19	20	14	12	17	17	24	26	77	0	0	18	11	18	16	8	11
2-MH	12	12	11	6	9	19	51	51	42	28	48	27	58	57	96	7	7	28	24	21	22	24	24
3-MH	10	16	13	8	12	20	57	59	53	35	58	27	68	66	80	6	10	28	23	19	21	28	29
1-HEPTENE	12	14	11	8	6	17	43	43	33	19	33	4	44	8	0	0	0	0	0	0	5	21	21
N-HEPTANE	6	10	16	7	9	14	40	41	39	25	43	19	51	88	76	0	4	22	22	14	16	23	26
M HEXANE	6	12	15	10	11	16	41	37	42	24	48	14	43	89	48	0	6	15	14	11	12	19	26
223,233-TMP	29	5	0	0	3	8	16	16	17	10	13	7	17	34	29	6	0	7	10	7	6	8	10
2,3,4 TMP	14	5	0	0	2	7	17	14	14	8	12	8	17	21	31	0	5	11	11	10	11	8	10
TOLUENE	0	28	24	17	21	44	91	94	128	63	111	75	121	190	264	34	17	66	65	52	52	55	57
M HEXENE	11	14	9	4	11	20	42	40	45	26	42	24	43		77	0	0	23	21	18	20	21	25
225-TMHEXENE	5	1	0	0	0	4	5	3	0	0	4		11									1	0
N-OCTANE	24	12	9	5	11	13	35	31	34	21	31	21	36	152	44	9	0	22	11	10	18	15	21
ETHYLBENZENE	13	8	4	0	4	12	29	22	26	14	20	18	27	66	52	11	6	16	15	14	12	12	11
M P XYLENE	10	26	14	11	18	29	77	74	82	47	71	66	84	304	198	23	23	64	58	48	46	42	41
O XYLENE	1	13	8	6	7	16	41	41	48	26	36	30	46			9	9	24	26	21	18	22	19
N-NONANE	23	13	10	8	10	13	28	26	30	25	41	28	53		47	8	8	12	9	13	9	17	16
PROPYLBENZEN	13	6	0	0	0	4	10	10	13	6	10		14									6	7
BUTYLBENZENE	10	23	14	12	16	26	60	53	58	42	54	38	56	155	98	15	13	30	29	25	22	37	36
N-DECANE	0	17	11	10	18	19	32	35	35	42	68	37	89		48	10	12	14	13	11	10	26	26
N-UNDECANE	10	10	8	5	12	10	19	18	22	18	24	17	35	25	29	5	9	11	12	7	10	13	14
N-DODECANE	0	0	1	0	0	0	10	4	159	5	10	0	13	13	8	0	0	0	6	0	0	5	4

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	0006	0106	0206	0306	0406	0506	0606	0706	0806	0906	1005	1105	1207	1307	1407	1507	1607	1710	1810	1910	2010	2110	2210	2310
ETHANE	34	64	66	55	128	93	116	90	112	99	45	138	57	27	102	102	135	107	155	158	183	64	81	38
ETHYLENE	22	23	20	11	78	145	232	143	232	188	64	84	94	36	164	214	274	219	380	345	319	96	97	20
ACETYLENE	21	25	29	14	75	160	256	163	256	224	73	86	92	39	183	326	294	222	411	373	319	106	96	29
PROPANE	26	47	55	46	139	70	109	79	129	123	39	481	62	26	149	96	180	68	135	134	139	49	56	37
PROPYLENE	11	12	7	4	27	53	94	56	87	75	14	48	38	6	38	72	74	88	167	148	122	52	46	17
FREON 12	0	0	0	0	0	0	23	0	9	7	0	4	2	0	1	20	5	7	17	22	0	0	0	0
ISOBUTANE	13	22	23	17	88	59	121	58	118	101	39	761	58	20	156	106	155	87	173	161	144	65	61	12
N-BUTANE	24	53	53	43	147	144	360	139	349	273	91		165	61	383	312	515	273	523	477	436	172	153	48
1-BUTENE	3	3	0	0	9	0	0	7	17	12	0	19	5	0	0	8	0	15	8	32	0	0	0	0
FREON 22	0	0	0	0	0	0	0	4	9	6	0	0	2	0	0	0	0	0	0	0	0	0	0	0
ISOBUTYLENE	10	12	11	7	24	0		30	47	38	0	0	19	0	24		43	45		18	60	56	0	0
2-BUTENE	0	0	0	0	0	0	21	8		16	0	56	7	0	7	0	16	14	33	85	20	0	0	0
BUTADIENE	0	0	0	0	0	29	35	18		25	0	35	10	0	8	21	18	21	49		35	50	0	0
ISOPENTANE	22	67	131	55	159	0	448	304	560	467	0		154	0	0	0	530	488	0	0	0	0	0	0
1-PENTENE	0	0	0	0	0	0	0	5	14	11	0	13	4	0	0	0	0	0	0	0	0	0	0	0
N-PENTANE	0	22	37	20	0	0	209	169	316	268	0	596	100	0	5	8	0	193	13	15	13	5	0	0
2-PENTENE	2	0	0	0	0	13	31	7	23	12	0	101	10	0	0	0	26	31	0	0	0	0	0	0
2-M BUTANE	0	0	0	0	22	29	35	18	37	26	0	38	7	0	0	5		24					21	0
2,2 DMB	4	3	5	0				13	23	18			7											
2M 1-PENTENE	20	0	0	0				3	6	4			0											
CYCLOPENTANE	14	4	8	3	7	14	22	20	40	33	10	40	12	6	14	20	31	21		31	25	11	12	6
2-MP	0	25	35	18	50	91	154	154	303	258	57	207	102	35	85	141	179	161	201	224	189	77	57	31
3-MP	8	17	25	12	32	54	92	105	195	169	37	122	72	23	52	91	124	99	124	133	116	45	34	20
1-HEXENE	0	0	2	0				0	20	15			6											
N-HEXANE	12	9	13	10	140	198	251	78	166	149	125		63	252	230	328		238	336	269	304	148	143	142
2-HEXENE	6	0	0	0				3	16	18			8											
2,2,3-TMB	7	14	18	12	51	54		76	139	125	48	88	52	53	64	87		76	92			45		40
CYCLOHEXANE	6	9	9	9	42	67		30	50	124	51	42	20	58	38	74	0		34			0	0	35
BENZENE	16	11	12	6	17	28	34	43	76	62	14	41	30	13	16	33	36	33	0	47	102	34	19	10
UNKNOWN	18	6	7	3	23	47	75	27	60	48	24	65	27	31	40	80	96	90		122	0	0	34	0
2-MH	16	15	21	12	40	70	117	89	166	133	38	70	58	34	60	101	125	120	154	0	112	43	49	20
3-MH	16	12	22	14	35	54		106	196	164	29	62	67	27	50	86		95			20	8		20
1-HEPTENE	14	13	20	12	0	0	0	60	112	92	0	2	37	0	0	0	0	4	0		0	0	0	0
N-HEPTANE	10	16	18	11	38	51	85	66	145	112	26	57	54	14	44	74	98	84	113	0	0	27	32	18
M HEXANE	8	16	16	10				63	117	104	19	37	42	12	34		66	52		27	29	18		12
223,233-TMP	31	6	9	8	13	18	32	23	42	37	12	19	18	9	17	31	35	32	44	47	42	0	14	7
2,3,4 TMP	14	7	6	6	13	22	0	22	36	35	13	20	13	9	20	26	35	42	57	25	0	0	0	10
TOLUENE	0	36	44	24	84	123	197	142	262	257	111	148	147	65	144	204	315	246		344	261		149	103
M HEXENE	11	16	18	13	31	53	80	66	98	98	36	48	47	24	52	102	95	83	108		103	43	45	28
225-TMHEXENE	8	0	0	0				10	9	11			9											
N-OCTANE	27	10	14	9	21	29	44	47	84	77	28	30	42	20	40	59	55	69				35	31	26
ETHYLBENZENE	13	9	8	7	21	37	53	37		62	25	40	30	17	29	57	70	65			67	30	25	24
M P XYLENE	12	27	33	21	80	120	185	124		213	91	121	90	60	125	180	227	209	273	298		128	98	56
O XYLENE	0	14	18	10		55		67		114	42	53	52	24	53	77	96	104		127	107	0	48	24
N-NONANE	26	14	17	11	25	27	41	43		71	39	34	61	14	33	54	57	56	58	50	9	0	20	10
PROPYLBENZEN	19	6	5	0				13		19			16											
BUTYLBENZENE	11	23	29	18	34	59	90	90		131	43	53	71	27	44	74	113	112	128	53	45	23	0	27
N-DECANE	0	22	29	19	25	22	32	48		80	30	33	154	15	26	38	57	45	51	36	31		0	16
N-UNDECANE	11	12	14	12	22	17	0	30		47	21	23	87	11	19	0	32	0	0	31	13	8	10	12
N-DODECANE	0	4	3	3	12	0	9	13		22	6	10	11	9	8	0	16	15	0	9	0	0	0	6

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	0010	0110	0210	0310	0410	0510	0610	0710	0810	1110	1210	1310	1410	1610	1710	1810	1910	2010	2110	2210	2310
ETHANE	42	37	50	37	62	15	12	8	7	19	22	8	14	7	6	5	8	25	8	112	7
ETHYLENE	21	0	20	21	10	8	0	5	7	7	7	5	0	0	9	0	5	24	7	47	0
ACETYLENE	22	8	16	24	17	0	0	6	9	8	10	7	5	33	9	6	5	26	10	74	0
PROPANE	27	20	37	28	44	12	8	10	7	6	8	8	10	9	6	3	9	27	8	441	7
PROPYLENE	1	0	5	9	5	0	0	0	0	0	0	0	6	0	0	0	4	15	5	50	0
FREON 12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ISOBUTANE	14	16	20	24	30	25	0	0	0	18	10	7	1	3	10	0	7	14	0	183	5
N-BUTANE	38	20	30	45	52	29	12	12	16	31	19	12	11	12	47	12	15	42	9	370	8
1-BUTENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	19	0
FREON 22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
ISOBUTYLENE	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	5	11	0	43	7
2-BUTENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	0
BUTADIENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0
ISOPENTANE	0	0	0	0	0	26	0	0	0	0	0	8	11	0	0	0	8	66	14	334	5
1-PENTENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0
N-PENTANE	0	0	0	0	0	5	0	0	11	0	0	5	8	0	23	0	4	20	0	275	0
2-PENTENE		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0
2-M BUTANE		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0
2,2 DMB												0					0	2		11	0
2M 1-PENTENE												0					0	0		4	0
CYCLOPENTANE	12	9	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	4	0	25	0
2-MP		0	16	0	21	9	0	0	7	0	0	3	4	0	20	0	3	18	7	138	0
3-MP	229	17	13	12	14	0	0	0	0	0	0	3	0	0	13	0	3	12	5	90	0
1-HEXENE												0					0	0		3	0
N-HEXANE	33	90	260	73	229	146	80	72	0	0	0	4	3	0	47	0	3	7	0	108	0
2-HEXENE												2					3	0		11	0
2,2,3-TMB	0	34	34	27	28	0	0	0	0	0	0	0	0	0	13	0	0	10	5	74	0
CYCLOHEXANE	0	0	39	32	21	15	4	0	35	0	0	0	0	0	35	0	0	4	0	19	0
BENZENE	16	8	18	13	14	0	0	0	16	0	0	0	0	0	0	0	0	5	0	59	0
UNKNOWN	15	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	5	0	19	0
2-MH	5	21	13	26	18	6	6	4	10	0	0	3	0	0	10	0	3	13	19	62	2
3-MH	10	10	13	25	19	0	0	5	0	0	0	3	0	0	9	0	5	15	0	76	2
1-HEPTENE	8	6	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	13	0	30	2
N-HEPTANE	4	8	18	27	23	0	0	0	9	2	0	1	0	0	0	0	3	12	0	80	2
M HEXANE	9	7	10	35	16	0	10		12	0	0	5	20	0	0	0	4	12	0	36	0
223,233-TMP	116	4	6	10	14	0	0	0	0	0	0	0	0	0	0	0	0	4	0	17	0
2,3,4 TMP	0	5	5	6	12	0	0	0	0	0	0	0	0	0	0	0	0	5	0	10	3
TOLUENE		152	76	59	48	27	9	15	18	0	0	6	17	0	29	0	6	28	28	106	14
M HEXENE	0	0	0	31	39	0	0	0	9	0	0	0	0	0	0	0	0	13	0	58	0
225-TMHEXENE												0					0	0		5	0
N-OCTANE	37	7	9	8	21	17	9	7	0	0	0	0	0	0	7	0	0	8	5	59	0
ETHYLBENZENE	29	9	9	12	8	0	0	0	0	0	0	0	0	0	0	0	0	5	0	22	0
M P XYLENE	12	23	31	32	32	0	31	18	70	0	0	7	23	0	20	0	7	25	25	75	10
O XYLENE		11	14	12	9	0	0	0	0	0	0	0	0	0	0	0	2	13	0	37	4
N-NONANE	22	9	10	9	6	0	0	0	0	0	0	0	0	0	0	0	4	10	0	50	2
PROPYLBENZEN												0					0	0		12	0
BUTYLBENZENE	10	30	14	26	16	18	3	11	15	0	0	2	0	0	0	0	5	19	0	43	0
N-DECANE	0	0	12	20	11	0	0	0	0	0	0	5	0	0	11	0	6	12	0	50	0
N-UNDECANE	10	8	9	10	9	18	6	0	14	0	0	3	0	0	0	0	3	8	0	40	2
N-DODECANE	0	0	0	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0

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	0010	0110	0210	0310	0410	0510	0610	0710	0810	0910	1010	1110	1210	1310	1410
ETHANE	60	39	43	32	29	36	41	66	80	53	43	45	0	35	54
ETHYLENE	44	20	16	7	4	8	25	68	160	112	79	62	0	51	86
ACETYLENE	52	23	16	7	4	11	48	77	180	140	83	81	198	60	130
PROPANE	60	43	53	31	23	34	33	67	97	66	52	49	759	38	60
PROPYLENE	22	11	9	6	0	5	9	33	63	45	25	37	0	26	40
FREON 12	0	0	0	0	0	0	0	0	6	3	0	0	0	0	0
ISOBUTANE	32	16	14	13	7	17	14	44	74	49	48	107	0	39	130
N-BUTANE	84	42	35	26	17	25	26	84	198	143	130	146		121	235
1-BUTENE	5	0	0	0	0	0	1	0	12	7	0	0	0	0	0
FREON 22	2	0	0	0	0	0	0	0	4	3	0	0	0	0	0
ISOBUTYLENE	14	8	10	7	6	7	7	19	35	24	7	15	0	0	30
2-BUTENE	4	0	1	0	0	0	0	4	13	7	0	0	0	0	12
BUTADIENE	5	0	0	0	0	0	0	7	19	13	0	0	0	0	0
ISOPENTANE	46	53	49	32	17.	36	40	148	301	224	133	0	0	0	0
1-PENTENE	0	0	0	0	0	0	0	0	6	4	0	0	0	0	0
N-PENTANE	0	20	19	12	4	12	12	67	173	119	0	0	0	0	5
2-PENTENE	6	0	0	0	0	0	0	0	8	0	0	0	0	52	111
2-M BUTANE	0	0	0	0	0	0	0	5	19	8	0	0	0	0	16
2,2 DMB	7	0	0	0	0	0	0	6	12	9					
2M 1-PENTENE	42	0	0	0	0	0	0	0	2	0					
CYCLOPENTANE	29	3	3	2	0	3	0	10	21	15	10	0	0	0	0
2-MP	0	18	20	11	0	17	11	60	165	119	49	22	0	12	16
3-MP	19	15	15	7	0	10	9	43	112	83	33	11	0	0	0
1-HEXENE	0	0	0	0	0	0	1	2	5	3					
N-HEXANE	23	4	12	4	0	9	5	36	97	71	63	28		28	92
2-HEXENE	12	0	0	0	0	0	0	4	13	7					
2,2,3-TMB	15	13	11	6	0	7	5	35	85	64	40	28	0	20	
CYCLOHEXANE	8	4	19	17	0	2	3	14	31	23	50	547	0	0	22
BENZENE	26	6	5	5	0	4	4	18	45	33	12	34	0	12	34
UNKNOWN	31	4	3	2	0	4	6	14	33	23	20	0	878	0	50
2-MH	26	14	14	7	0	8	9	37	95	68	32	32	0	39	70
3-MH	27	14	14	8	6	8	10	45	112	81	30	31	0	32	54
1-HEPTENE	32	12	15	6	5	6	9	29	66	49	0	0	0	0	0
N-HEPTANE	11	11	12	338	4	6	7	33	79	60	21	27	0	25	49
M HEXANE	10	13	13	8	3	8	7	29	69	56	15	20	0	24	31
223,233-TMP	76	4	6	0	0	2	0	14	29	20	9	9	0	10	20
2,3,4 TMP	30	4	5	0	0	0	0	9	22	18	10	12	0	10	17
TOLUENE	0	50	46	36	5	28	16	56	150	119	79	141	185	89	197
M HEXENE	20	14	14	10	0	7	7	33	65	53	27	35	0	32	66
225-TMHEXENE	12	0	0	0	0	0	0	3	7	5					
N-OCTANE	43	9	9	4	0	3	5	23	48	41	17	23	766	21	41
ETHYLBENZENE	23	8	7	3	0	4	7	15	40	40	20	21	0	17	34
M P XYLENE	17	21	19	10	4	9	13	55	132	139	78	63	44	70	143
O XYLENE	4	11	8	6	2	6	8	30	71	76	25	43	0	27	51
N-NONANE	35	8	8	6	4	5	7	18	42	36	13	25	0	17	20
PROPYLBENZEN	23	0	0	0	0	0	0	8	17	12					
BUTYLBENZENE	14	17	17	10	5	7	12	41	101	73	27		0	0	39
N-DECANE	7	13	12	8	5	8	11	17	47	32		22	0	0	0
N-UNDECANE	14	9	8	7	4	4	7	10		20	12	15	0	6	0
N-DODECANE	7	0	0	0	0	0	0	8		13	5	3	0	0	0

THE BROWN CLOUD OF DENVER

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ABSTRACT

The urban haze NE of Denver appeared very dark against the horizon on the morning of 21 November 1973. The visual appearance is shown to be predominately due to aerosol optical properties and not to NO_2. The analysis is based on simplified radiative transfer theory and atmospheric data taken by participants in the Denver Air Pollution Field Study.

INTRODUCTION

Air pollution, or more specifically, suspended particulate matter or aerosol, can dramatically alter the optical properties of air. Visibility is often reduced from that limited by Rayleigh scattering, of order 300 kilometers, to a few kilometers or less. Wavelength dependent extinction by suspended particles and/or NO_2 can alter the color of distant bright objects.[1-5] NO_2 and/or the suspended particles can also produce haze layers of various colors that appear light or dark against the horizon. The specific case considered in this paper is the dark cloud NE of Denver typical of pollution episodes.

Theory

The brightness of a layer at any wavelength can be calculated in a manner similar to that of Middleton.[1] Consider an observer viewing the horizon from position r_o. In a narrow band of wavelengths centered on λ, a certain level of radiance*, $I_h(r_o,\lambda)$ of light reaches the observer from the horizon. The perceived brightness and color of the horizon is determined by the radiance as a function of wavelength. The horizon

*The units of radiance, $I(r,\lambda)$ are ergs (sec. x Ω x cm^2 x $\Delta\lambda)^{-1}$.

radiance as a function of observer position near an initial position, r_o, is given by

$$I_h(r_o+dr,\lambda) = I_h(r_o,\lambda) + \frac{dI_h(r_o,\lambda)}{dr}\, dr. \qquad (1)$$

The change in radiance as the observer moves dr away from the horizon is due to two phenomena: (1) $I_h(r_o,\lambda)$ will be decreased by extinction in traversing the thickness dr; (2) $I_h(r,\lambda)$ will be increased by light entering the thickness dr from any direction and being scattered toward the observer. This change of radiance with position can be written as

$$\frac{dI_h(r,\lambda)}{dr} = -\sigma(r_o,\lambda)I_h(r_o,\lambda) + I_a(r_o,\lambda) \qquad (2)$$

σ is the volume extinction coefficient that operates to decrease radiance and I_a (the so-called air-light term) is the radiance of a layer of air dr in thickness. The source of this radiance is scattering by particles in the element dr under illumination by direct, scattered and reflected sunlight. More specifically

$$I_a(r,\lambda) = \int_o^{4\pi} I_s(\Theta',\Phi')\ \beta(\Theta)d\Omega, \text{ evaluated at } r,\lambda. \qquad (3)$$

Where $I_s(\Theta',\Phi')$ is the illumination radiance as a function of direction (Θ',Φ') that is incident on the element dr and $\beta(\Theta)$ is the volume scattering phase function for the angle between the incident direction and the direction toward the observer. The integration over solid angle relates the incident illumination and scattering phase function to air-light in the direction toward the observer.

Equation 3 is not generally useful in that both the incident illumination and scattering phase function are usually unknown. However, some general statements can be made. Clearly the magnitude of I_a depends on the magnitude and angular dependence of both illumination and the scattering phase function.

Two contrasting examples of illumination would be (1) a clear sky with the direct solar beam at angle (Θ',Φ') dominating scattered radiation and (2) an overcast day with the sky acting as a diffuse source of light. For aerosol scattering, β is strongly peaked in the forward direction producing a relatively large value of I_a on a clear day when the scattering angle Θ for the direct solar beam is less than 45° and a relatively small value of I_a when Θ is greater than 90°. See Figure 1 for definition of Θ.

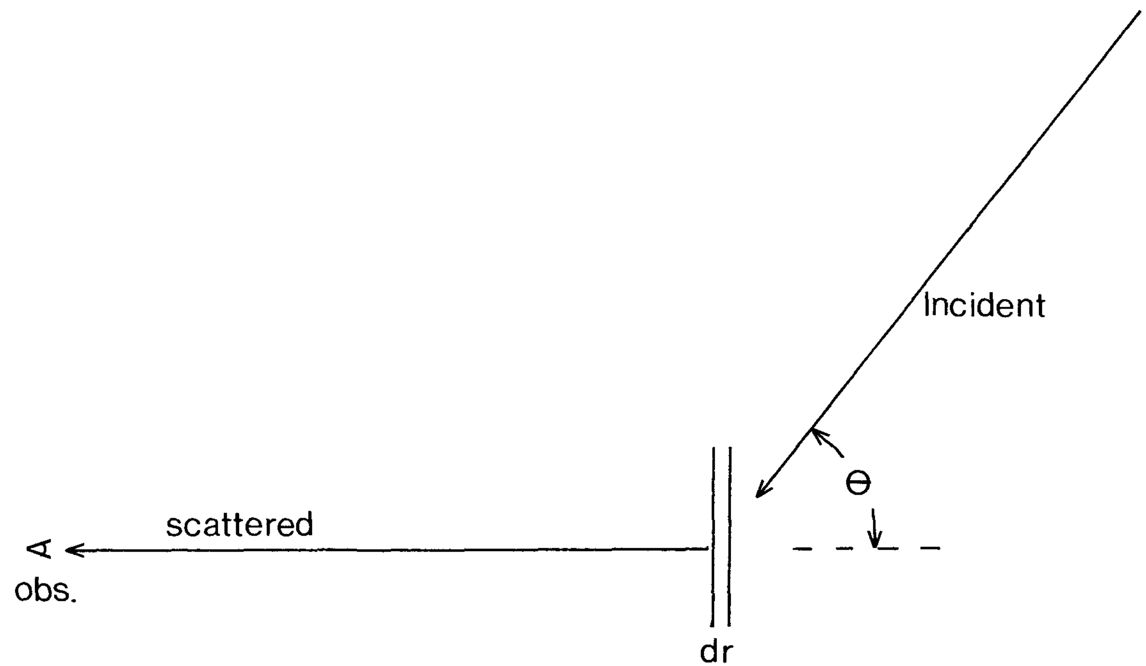

Figure 1. Schematic of the observer, volume element dr, incident and scattered illumination directions and scattering angle, θ.

Equation 2 can be used to calculate the radiance of a layer if the layer is optically thick in the horizontal direction and horizontally uniform. The radiance of the layer is not a function of observer position because the decrease of radiance by extinction is exactly balanced by the increase from the air-light[1].

$$\frac{dI_h(\lambda)}{dr} = 0 = -\sigma(\lambda)\ I_h(\lambda) + I_a(\lambda) \tag{4}$$

$$\sigma(\lambda) I_h(\lambda) = I_a(\lambda) \tag{5}$$

$$I_h(\lambda) = \frac{I_a(\lambda)}{\sigma(\lambda)} \tag{6}$$

Equation 6 shows that the radiance of this layer at each wavelength is given by the ratio of the air-light term to the extinction coefficient and the layer's visual appearance in terms of color, brightness, etc. would be determined by the wavelength dependence of radiance.

The magnitude of the air-light term is determined by the angle Θ and the magnitude and angle dependence of the volume scattering phase function. The extinction coefficient is the sum of extinction due to aerosol optical scattering, and extinction due to absorption by the aerosol and by NO_2. If a smog layer is visibly dark, usually the layer is viewed in backscatter, i.e., the angle Θ is 90° or larger, and the extinction coefficient is relatively large.

MEASUREMENT OF EXTINCTION

The relative magnitudes of aerosol and NO_2 extinction must be known to estimate the effect of each on the visual appearance of a layer under a given condition of illumination. On 21 November 1973, four different groups were making measurements of aerosol extinction and NO_2 or NO_x concentration as listed below:

1. University of Washington (U. of W.) - aerosol scattering and absortion extinction coefficients.

2. Environmental Protection Agency (EPA) - NO_2 and aerosol scattering extinction coefficient (500 nm).

3. General Motors (GM) - NO_2 and aerosol scattering extinction coefficient (500 nm).

4. Meteorology Research, Inc. - NO_x and aerosol scattering extinction coefficient (500 nm).

U. of W. and EPA were located 10 km NNW of downtown Denver at the Trout Farm Site. GM was located 5 km NNW of downtown Denver. The MRI data is from an aircraft sounding covering 60 to 600 meters local elevation above Standley Lake about 12 km NW of downtown Denver. Data taken by the four groups are not ideal in that the aircraft measurements were of NO_x rather than NO_2 and the aerosol absorption extinction coefficient was measured as an average over two hour periods and only at the U. of W. site. The relative extinction of NO_2 and aerosol particles can be determined if the following assumptions are made:

1. Aircraft data for NO_x is assumed to be 70% NO_2. This is mean of the average ratios for GM (80%) and EPA (60%) during the period 0900-1200 on 21 November.

2. The ratio of aerosol extinction to aerosol scatter coefficients is the same as measured by U. of W. (1.5) during 0830-1330 on 21 November.

3. Aerosol extinction is assumed to have wavelength dependence of λ^{-1}.

Using these assumptions and data supplied by Jack Durham (EPA), Jerry Anderson (MRI) and Martin Ferman (GM), Table 1 lists the fraction of extinction due to NO_2 extinction[6] as a function of site and wavelength for the morning of 21 November, 1973.

TABLE 1. FRACTION OF EXTINCTION DUE TO NO_2

λ \ site	EPA	GM	MRI Standley Sounding
400 nm	.10	.40	.36
450 nm	.09	.35	.32
500 nm	.06	.25	.22
550 nm	.03	.13	.11

PHOTOGRAPHIC OBSERVATIONS

The visual effect of scattering angle is shown in the pair of photographs, Figures 2 and 3. Both show the central business district of Denver immersed in haze as photographed from an aircraft on the morning of 21 November 1973. Figure 2, taken about 11:00 a.m., shows Denver as viewed from North looking South and the scattering angle is about 30°.

Figure 2. Denver photographed from the North looking South at about 11:00 a.m. on 21 November 1973. Note the central business district in the upper left quadrant. The urban haze is bright when viewed at a scattering angle of about 30°.
Photography by: Charles E. Grover
Denver, Colorado

The haze is bright against the horizon.

Figure 3, taken at 11:20 a.m., shows a view of Denver from the South looking North with a scattering angle of about 150°. Under these conditions, the haze surrounding the central business district appears as a dark layer against the horizon. During the interval between photographs the wind velocity, as measured at the GM and EPA sites was 3 to 5 Km per hour indicating that the difference between the photographs is not due to transport.

These photographs are consistent with the results summarized in Table 1, i.e., aerosol dominates extinction. For a small scattering angle, as in Figure 2, the haze layer is bright against the horizon where as the same layer, shown in Figure 3 with a large scattering angle, appear dark.

CONCLUSIONS

Photographs supplied by Loren Crow show that the urban cloud of Denver on 21 November 1973 was dark only when observed at large scattering angles and appeared bright under small scattering angles. The dark haze layer typically observed under pollution episode conditions NE of Denver is dark because this is the direction of observation that minimizes the air light term in Equation 6. The extinction of aerosol particles seems to dominate that of NO_2 by a factor of two to one or greater at wavelengths longer than 450nm. The measured concentration of NO_2 would make the Denver haze layer slightly less blue and more yellow under all conditions of illumination.

The photographs and measurements of aerosol optical parameters and NO_2 concentration shows that the dark cloud of Denver is an aerosol optical effect with NO_2 absorption playing a minor role.

ACKNOWLEDGEMENTS

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J. Durham, Environmental Protection Agency
M. Ferman, General Motors Research Laboratories
L. Crow, Consulting Meteorologist, Denver.

Figure 3. Denver photographed from the South looking North at about 11:20 a.m. on 21 November 1973. The central business district is located slightly to the right of center, one-fourth part down from the top. The light urban haze shown in Figure 2 is dark under these observation conditions.
Photography by: Charles E. Grover
Denver, Colorado

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6. NO_2 extinction as a function of wavelength is from reference 2.

HIGH-VOLUME AMBIENT AIR SAMPLING IN DENVER, COLORADO, DURING NOVEMBER 1973

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ABSTRACT

This paper summarizes data from sixteen high-volume air samplers operated in the metropolitan Denver area in November 1973. Total suspended particulates and the benzene-soluble organic content of the collected particulates are discussed in relationship to experiments and observations by others during the "Brown Cloud Study -- 1973."

INTRODUCTION

The Colorado Department of Health participated in the 1973 "Brown Cloud Study" in numerous roles. The Air Pollution Control Division's meteorologist, William Retallack, made forecasts and recommendations for intensive sampling days. The Air Quality Monitoring Unit operated six continuous air monitoring stations in the metro Denver area, at which gaseous pollutants were measured.[1]

The Air Pollution Laboratory staff gave field assistance to participating research groups: pilot-balloon tracking crews, preparation of sampling media and special samples, and other logistic support. As an extension of routine sampling programs, the Air Pollution Laboratory also coordinated the operation of high-volume air samplers to obtain data coinciding with the intensive sampling days. The resulting data on total suspended particulates is the subject of this report.

One of the major thrusts of air pollution control efforts has been the reduction of airborne particulate matter. A large amount of historical data is available concerning suspended particulate levels throughout

Denver and Colorado. Standards and goals for reduction of suspended particulates have been set at both national and state levels, based on measurements of total suspended particulates (TSP) by the high-volume Reference Method.[2]

Even though such measurements provide only gross data for preliminary assessments of air quality, it is important that the data be available for correlation with research measurements of other, more specific parameters. Further, the high-volume sampling technique affords materials from which analyses can proceed for benzene-soluble organics (BSO), metals, and limited microscopic examination.

EXPERIMENTAL

The high-volume air samplers were located at sixteen established stations, shown in Figure 1 with detailed locations given in Appendix 1. Each station was equipped with an aluminum shelter, General Metal Works Model 2000-H* sampling unit with standard 8x10 inch filter holder, and a 7-day clock timer control. Air flow rates were measured by ball-float rotameters. Each individual sampling unit with rotameter was calibrated in October 1973 against a calibrated orifice gauge.[2] Calculation of air volumes by linear integration between initial and final flowrates has been found to give results consonant with the precision of other sampling variables, because of the generally low relative humidity, quantity, and nature of ambient pollutants occurring in the Denver area.

The High-Volume Air Sampling Network in Colorado routinely collects a 24-hour sample every fourth day, midnight to midnight. This schedule was extended by 24-hour samples on additional even-numbered days, as shown in Figure 2. When "alerts" were called for odd-numbered days, station operators ran the samplers from morning to evening, to permit changing filters to maintain the 24-hour alternate-day schedule. The 7-to-15-hour samples thus collected during odd-numbered alert days contained sufficient material for precision in measurement; but it should be recognized that these results involve time-averaging of TSP levels over a fraction of the standard 24-hour sampling day.

Complete sets of samples and data were not obtained at all stations. Security regulations at some commercial, industrial, and public buildings prevented access to Hi-Vol samplers to change filters outside of business hours. Failures of equipment and a laboratory accident are denoted by *NG* and *LA*, respectively, in tables of data.

Samples were collected on fiber-glass filters, specified with >99.95% retention of 0.3 μm DOP aerosol. Filters were conditioned before and after sampling in an air-conditioned, controlled-humidity laboratory.

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* Mention of commercial items by name is for convenience in identification, and does not imply endorsement by the Colorado Department of Health.

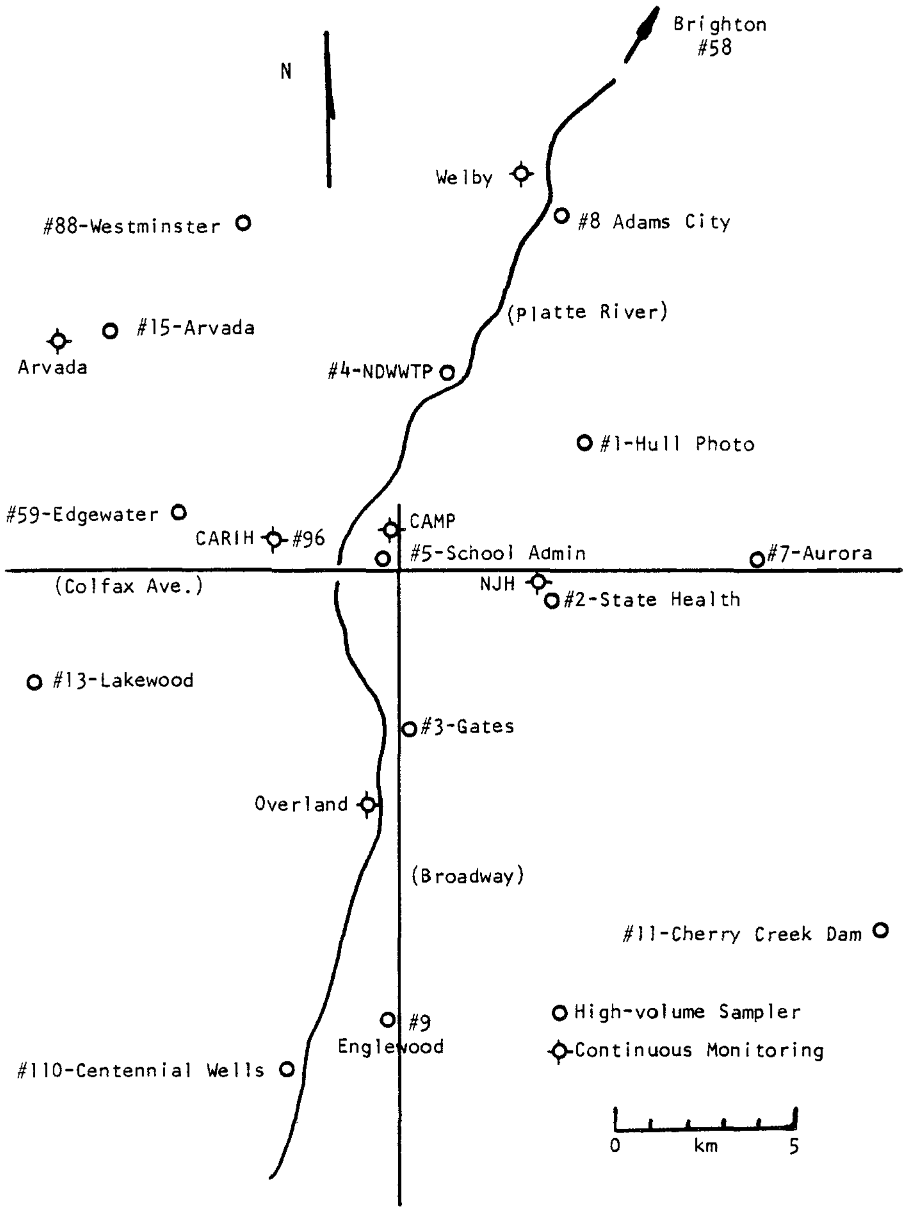

Figure 1. Outline map of sampling station locations.

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
				1	2	3
4	5	$\boxed{6}$	7	8	9	$\boxed{10}$
11	12	13	$\boxed{14}$	15	16	17
$\boxed{18}$	19	20	21	$\boxed{22}$	23	24
25	$\boxed{26}$	27	28	29	$\boxed{30}$	

= Regular sampling day, 0000-2400 hours (*R* on data tables).

= Extra sampling day, 0000-2400 hours (*E* on data tables).

= Alert sampling day, 7-15 hour intervals (*A* on data tables).

Figure 2. High-volume air sampling schedule, November 1973.

Filters were retained from each batch and carried as blanks through analytical procedures as appropriate.

Determinations of total suspended particulates were made according to standard procedures.[2] Benzene-soluble organic fractions were determined from one-half of each filter, by procedures involving approximately 50 cycles of extraction by hot benzene in a Soxhlet extractor over a 6-hour period, and evaporation of benzene from the extracted residue to a final temperature about 60°C.

Composites of strips cut from filters were treated in a TracerLab Model 505 Low Temperature Asher to destroy organic matter, and were refluxed in 3 ***M*** nitric acid. Extracted metal ions were determined by a Unicam SP-90 atomic absorption spectrophotometer.

RESULTS AND DISCUSSION

The results for total suspended particulates and benzene-soluble organic are summarized in Tables 1 and 2. Units are micrograms per cubic meter. A third value for each sample (%O/P) gives the BSO fraction as a weight percentage of TSP.

Stations have been grouped by topographic locations to facilitate comparisons of particulate levels. Table 1 includes stations close to the Platte River, generally on its lower terraces. These stations lie nearest the major industrial and vehicular sources of pollutants; they are ventilated last when rising temperatures break inversion conditions;

TABLE 1. HIGH-VOLUME AIR SAMPLES AT VALLEY-LOWER TERRACE STATIONS

	#3-Gates			#4-NDWWTP			#5-School Ad			#8-Adams City			#9-Englewood			#15-Arvada			#96-CARIH			#110-Cen.Wells		
Date/Day	TSP	BSO	%O/P	TSP	BSO	%O/P	TSP	BSO	%O/P	TSP	BSO	%O/P	TSP	BSO	%O/P	TSP	BSO	%O/P	TSP	BSO	%O/P	TSP	BSO	%O/P
11/04-Sun-R	120	9.5	7.9	67	1.5	2.2	100	8.4	8.4	50	3.0	6.0	137	10.7	7.8	86	6.6	7.7	80	6.0	7.5	101	7.9	7.9
11/06-Tue-E	329	29.5	9.0	241	15.7	6.5	329	26.1	7.9	206	13.9	6.7	219	17.2	7.9	305	23.2	7.6	231	27.7	12.0	165	15.7	9.5
11/07-Wed-A	277	20.6	7.4	174	6.5	3.7	ns	ns	---	216	6.9	3.2	207	13.2	6.4	246	13.3	5.4	167	6.7	4.0	169	7.4	4.4
	(0910-1645)			(0935-1835)						(0905-1910)			(0840-1730)			(0815-1958)			(1000-2100)			(0901-1800)		
11/08-Thu-R	212	15.4	7.3	153	7.4	4.8	202	14.0	6.9	107	4.1	3.8	172	11.3	6.6	146	9.0	6.2	175	8.6	4.9	168	12.7	7.6
11/09-Fri-A	407	41.5	10.2	230	13.5	5.9	ns	ns	---	204	12.0	5.9	338	25.8	7.6	351	19.2	5.5	393	28.8	7.3	360	30.4	8.4
	(0905-1900)			(0930-1930)						(0850-1900)			(0857-1925)			(1000-2005)			(0955-2045)			(0821-1940)		
11/10-Sat-E	205	17.4	8.5	241	26.7	11.1	150	16.0	10.7	186	14.7	7.9	129	10.5	8.1	152	14.8	9.7	147	17.3	11.8	107	7.2	6.7
11/12-Mon-R	312	26.2	8.4	485	41.0	8.5	ns	ns	---	258	8.9	3.4	155	12.4	8.0	216	7.6	3.5	181	13.7	7.6	89	2.5	2.8
11/14-Wed-E	249	20.6	8.3	279	22.1	7.9	210	16.1	7.7	138	7.7	5.6	122	5.9	4.8	86	4.3	5.0	107	8.8	8.2	74	5.8	7.8
11/16-Fri-R	279	20.2	7.2	339	29.2	8.6	228	21.6	9.5	278	13.5	4.9	161	10.1	6.3	222	14.1	6.4	214	3.4	1.6	145	6.5	4.5
11/17-Sat-A	144	5.8	4.0	163	4.2	2.6	ns	ns	---	ns	ns	---	113	5.7	5.0	115	3.7	3.2	96	2.4	2.5	127	4.4	3.5
	(0850-1955)			(0933-2005)									(0915-2015)			(0920-2025)			(0915-2053)			(0930-2035)		
11/18-Sun-E	194	22.5	11.6	ns	ns	---	ns	ns	---	142	12.3	8.7	133	13.5	10.2	111	11.3	10.2	138	20.0	14.5	138	7.6	5.5
11/20-Tue-R	112	14.0	12.5	157	17.4	11.1	129	13.3	10.3	103	10.6	10.3	120	13.3	11.1	127	14.8	11.7	88	12.2	13.9	60	5.0	8.3
11/21-Wed-A	250	13.0	5.2	248	14.7	5.9	ns	ns	---	259	17.0	6.6	300	*LA*	---	347	16.1	4.6	319	23.6	7.4	157	12.5	8.0
	(0915-1625)			(0945-1655)						(0828-1625)			(0905-1730)			(0830-1930)			(1015-2000)			(0835-1755)		
11/22-Thu-E	118	8.4	7.1	89	7.3	8.2	112	9.3	8.3	78	7.8	10.0	95	13.8	14.5	140	11.5	8.2	97	11.4	11.8	59	7.7	13.1
11/24-Sat-R	135	11.7	8.7	130	10.0	7.7	ns	ns	---	98	6.8	6.9	129	8.3	6.4	229	19.8	8.6	136	9.9	7.3	73	8.8	12.1
11/26-Mon-E	247	21.5	8.7	149	8.5	5.7	ns	ns	---	133	10.6	8.0	121	7.3	6.1	199	4.9	2.5	154	9.4	6.1	88	4.7	5.3
				(1145-2400)						(1045-2400)														
11/28-Wed-R	285	28.2	9.9	222	19.9	9.0	273	15.7	5.8	164	3.8	2.3	189	17.7	9.4	199	9.9	5.0	111	7.0	6.3	97	4.0	4.1
11/30-Fri-E	616	41.0	6.7	325	36.6	11.3	359	42.0	11.7	268	33.3	12.4	398	29.8	7.5	321	19.9	6.2	228	20.5	9.0	271	19.5	7.2

Units: $\mu g/m^3$ | $\mu g/m^3$ | BSO/TSP, %

TABLE 2. HIGH-VOLUME AIR SAMPLES AT UPPER TERRACE AND MISCELLANEOUS STATIONS

Date/Day	#1-Hull Photo			#2-St.Health			#7-Aurora			#11-Cherry CD			#13-Lakewood			#59-Edgewater			#88-Westm'ster			#58-Brighton		
	TSP	BSO	%O/P	TSP	BSO	%O/P	TSP	BSO	%O/P	TSP	BSO	%O/P	TSP	BSO	%O/P	TSP	BSO	%O/P	TSP	BSO	%O/P	TSP	BSO	%O/P
11/04-Sun-R	63	3.8	6.0	80	5.7	7.1	61	2.6	4.3	123	8.6	7.0	74	8.0	10.8	55	-	-	54	2.6	4.8	220	9.9	4.5
11/06-Tue-E	200	17.5	8.8	174	21.8	12.5	107	4.3	4.0	97	7.5	7.7	-	-	-	-	-	-	-	-	-	-	-	-
11/07-Wed-A	-	-	-	94	3.9	4.1	73	5.0	6.8	129	11.4	8.8	-	-	-	-	-	-	-	-	-	-	-	-
				(0833-1810)			(0830-1840)			(0845-1845)														
11/08-Thu-R	117	6.9	5.9	121	7.2	6.0	88	7.0	8.0	92	5.7	6.2	139	7.7	5.5	138	-	-	111	5.9	5.3	99	4.5	4.5
11/09-Fri-A	-	-	-	181	17.5	9.7	136	12.4	9.1	144	9.9	6.9	-	-	-	-	-	-	-	-	-	-	-	-
				(0815-1850)			(0835-1757)			(0835-2025)														
11/10-Sat-E	85	8.3	9.8	82	8.1	9.9	96	6.4	6.7	57	2.6	4.6	-	-	-	-	-	-	-	-	-	-	-	-
11/12-Mon-R	-	-	-	121	4.2	3.5	156	6.8	4.4	50	2.1	4.2	107	5.2	4.9	162	-	-	172	11.7	6.8	167	9.3	5.6
11/14-Wed-E	130	7.3	5.6	111	8.7	7.8	90	4.1	4.6	84	3.4	4.0	-	-	-	-	-	-	-	-	-	-	-	-
11/16-Fri-R	154	14.1	9.2	148	12.1	8.2	138	11.1	8.0	92	1.5	1.6	150	12.4	8.3	202	-	-	167	8.4	5.0	191	9.0	4.7
11/17-Sat-A	-	-	-	61	3.5	5.7	87	2.7	3.1	90	2.9	3.2	-	-	-	-	-	-	-	-	-	-	-	-
				(0820-1905)			(0800-1830)			(1000-2110)														
11/18-Sun-E	-	-	-	120	13.0	10.8	126	13.3	10.6	62	2.6	4.2	-	-	-	-	-	-	-	-	-	-	-	-
11/20-Tue-R	71	8.7	12.3	57	7.1	12.5	102	10.0	9.8	30	1.9	6.3	58	7.7	13.3	69	-	-	97	5.8	6.0	77	3.5	4.5
11/21-Wed-A	-	-	-	110	6.8	6.2	153	11.8	7.7	50	0.7	1.4	-	-	-	-	-	-	-	-	-	-	-	-
				(0855-1640)			(0845-1745)			(0940-1840)														
11/22-Thu-E	80	8.6	10.8	77	11.5	14.9	83	9.0	10.8	45	4.1	9.1	-	-	-	-	-	-	-	-	-	-	-	-
11/24-Sat-R	63	7.5	11.9	63	8.9	14.1	91	9.0	9.9	31	1.7	5.5	128	15.5	12.1	166	-	-	128	13.6	10.6	137	6.2	4.5
11/26-Mon-E	-	-	-	89	9.1	10.2	108	8.4	7.8	52	3.1	6.0	-	-	-	-	-	-	-	-	-	-	-	-
				(0900-2400)			(1015-2400)																	
11/28-Wed-R	116	12.0	10.3	*NG*	-	-	228	13.8	6.1	58	4.8	8.3	95	7.7	8.1	32	-	-	68	4.5	6.6	69	3.9	5.7
11/30-Fri-E	186	25.1	13.5	185	18.4	9.9	234	24.3	10.4	172	10.6	6.2	-	-	-	-	-	-	-	-	-	-	-	-

Units: $\mu g/m^3$ | $\mu g/m^3$ | BSO/TSP, %

and they are subjected to repeated passage of polluted air masses during diurnal up-slope/down-slope air drainage.

Station #15 (Arvada) is included with this group of stations. This station is located on a lower terrace of Clear Creek, a major tributary of the Platte River. Interstate I-70 runs along the south side of Clear Creek valley, and considerable industrial activity is also located there. Pollutant sources and air movement characteristics are thus comparable in both the Platte River and Clear Creek valleys; this is reflected in most TSP and BSO levels shown in Table 1.

Table 2 includes stations located away from the valleys, on upper terraces and toward the edges of the Denver Basin. Station #58 (Brighton) is included in Table 2. Although it lies in the Platte River valley about 20.4 km NNE of Station #8 (Adams City), TSP values at Brighton often do not correlate with values at the other valley stations.

Station #11 (Cherry Creek Dam) was originally installed to supply remote, suburban background values for TSP in the Denver area. Growth of Denver toward the southeast has brought highways and residential developments near Station #11; it is becoming much like the other suburban stations. It is noteworthy that a TSP level of 172 $\mu g/m^3$ appeared at Station #11 on Friday, 30 November 1973; most of the other stations also showed highest TSP values on that day.

The percentage extractable organic content (BSO) is of special interest in suggesting origins of the associated particulate matter. Particulates collected in remote and rural areas of Colorado, where dust from soils is the principal constituent of the TSP, usually show less than 2-3% BSO/TSP.

Urban areas with many vehicular sources commonly show 5-15% BSO/TSP. This percentage has decreased on average during the past decade, presumably due to improved vehicle emissions controls. But high percentages of BSO/TSP still occur on many winter days. A case at hand is the Thanksgiving Day holiday, 22 November 1973. TSP levels were generally moderate, but organic levels were high on that day of heavy traffic.

A different indicator associating vehicle emissions with the particulate pollution is afforded by analyses for metals. These are shown in Table 3, and pertain to composites of strips from filters on the regular (*R*) sampling days. Apart from constituents of the common silicate minerals, the metals in Table 3 are the ones routinely measured in Denver's suspended particulates. It is notable that lead constitutes 1.0-1.4% of the TSP on a weight basis, indicating a fairly uniform contribution to the average TSP regardless of location.

TABLE 3. METALS IN COMPOSITE SAMPLES FROM

REGULAR SCHEDULED SAMPLING DAYS, NOVEMBER 1973.

Station	Copper		Iron		Lead		Zinc	
	μg/m³	mg/gm[a]	μg/m³	mg/gm	μg/m³	mg/gm	μg/m³	mg/gm
#2	0.17	1.75	1.3	13.4	1.3	13.4	0.12	1.2
#3	0.52	2.55	3.6	17.6	2.8	13.6	0.47	2.3
#4	0.18	0.85	4.8	22.1	2.8	12.8	0.26	1.2
#5	0.27	1.47	3.0	16.2	2.1	11.4	0.58	3.1
#8	0.06	0.38	3.0	20.1	2.2	14.3	0.17	1.2
#9	0.12	0.76	2.7	17.8	2.1	13.6	0.22	1.4
#11	0.22	3.24	0.9	13.9	0.8	11.6	0.13	1.9
#15	0.10	0.62	3.5	20.6	1.7	10.1	0.10	0.6
#110	0.06	0.53	1.9	17.8	1.3	11.9	0.18	1.7

[a]mg/gm TSP in composite sample.

Finally, we may look backward to November 1973 and ask whether it was a favorable month for studying the "Brown Cloud." From the viewpoint of total particulates, it was indeed an excellent month. The average TSP level for regular sampling days in November 1973 was 20-40% higher than comparable averages in most previous years. Only November 1971 was similar to November 1973. We were thus fortunate that intensive study efforts were undertaken in those two months, and we anticipate much benefit from the research efforts in those auspicious months.

ACKNOWLEDGMENTS

Thanks are extended to the leaders of environmental sections of three local agencies, and to their staff members especially, for cooperation and much extra work in obtaining the numerous special samples in this study: Messrs. Thomas Peabody and Thomas Bullock of Denver Department of Health and Hospitals; Mr. Melvin Davis of Jefferson County Health Department; and Messrs. Donald Turk and Peter Murray of Tri-County District Health Department. Messrs. Richard Fox, David Wickham, Charles Bray, and Norman Weigel shared the brunt of extra work outside and in the Air Pollution Laboratory.

REFERENCES

1. The extensive data from the continuous monitoring stations and the high-volume particulate sampling network have been entered in the National Aerometric Data Bank in SAROAD format. A synopsis of data from the continuous monitoring stations during November 1973 may be requested from the Air Quality Surveillance Section, Air Pollution Control Division, Colorado Department of Health, Denver, Colorado 80220.

2. Tentative method of analysis for suspended particulate matter in the atmosphere: High-volume method, 11101-01-70T. In: Intersociety Committee, Methods for Air Sampling and Analysis (Washington, D.C.: American Public Health Assoc., 1972), pp. 365-372.

Appendix 1. LOCATIONS OF HIGH-VOLUME AIR SAMPLING STATIONS

SAROAD Station Codes follow the Colorado Station numbers. Grid coordinates are given to the nearest 20 meters (UTM Zone 13), and sampler elevations to the nearest 10 feet; locations are estimated from U. S. Geological Survey 7.5-minute quadrangle maps (1:24000). Identification by landmark buildings conveys no implication as to sources of measured pollutants.

#1.	06-0580-006	Hull Photo Co., 5105 E. 38th Ave., Denver. E 0506 220 / N 4402 180 El. 5270 ft.
#2.	06-0580-007	State Health Department, 4210 E. 11th Ave., Denver. E 0505 340 / N 4397 860 El. 5320 ft.
#3.	06-0580-003	Gates Rubber Co., 1050 South Broadway, Denver. E 0501 180 / N 4394 080 El. 5260 ft.
#4.	06-0580-004	N. Denver Waste Water Plant, E. 51st Ave. & Marion. E 0502 360 / N 4404 100 El. 5140 ft.
#5.	06-0580-001	School Administration Bldg., 414-14th St., Denver. E 0500 680 / N 4398 820 El. 5220 ft.
#7.	06-0140-001	Aurora: 1633 Florence St. E 0511 000 / N 4398 980 El. 5340 ft.
#8.	06-0020-001	Adams City: 4301 East 72nd Avenue. E 0505 540 / N 4408 420 El. 5130 ft.
#9.	06-0780-001	Englewood: 4857 South Broadway. E 0501 040 / N 4386 300 El. 5410 ft.
#11.	06-0080-001	Cherry Creek Dam: South Scranton St. & Floyd Ave. E 0514 400 / N 4387 600 El. 5650 ft.
#13.	06-1260-001	Lakewood: 260 South Kipling St. E 0490 760 / N 4395 600 El. 5580 ft.
#15.	06-0120-001	Arvada: 7622 Grandview Avenue. E 0493 000 / N 4405 300 El. 5340 ft.
#58.	06-0240-001	Brighton: 15 South Main St. E 0515 540 / N 4426 220 El. 4980 ft.
#59.	06-0720-001	Edgewater: 25th Avenue & Gray Street. E 0494 800 / N 4400 160 El. 5350 ft.
#88.	06-2240-002	Westminster: 70th Avenue & Utica Street. E 0496 580 / N 4408 260 El. 5320 ft.
#96.	06-0580-009	CARIH: 21st Ave. & Julian St. [National Asthma Center; formerly Children's Asthmatic Research Institute and Hospital]. E 0497 300 / N 4399 580 El. 5320 ft.
#110.	06-1420-002	Littleton, Centennial Wells: NW Bowles Ave. & Santa Fe Drive E 0497 860 / N 4384 760 El. 5320 ft.

Appendix 2. LOCATIONS & METHODS OF CONTINUOUS AIR MONITORING STATIONS

06-0120-002 Arvada; West 57th Ave. & Garrison St. (a,b,c,g,i)
E 491 460 / N 4405 040
(Ca. 1.6 km at azimuth 275 from Hi-Vol Station #15)

06-2210-001 Welby: East 78th Ave. & Steele St. (a,b,c,g,i)
E 504 380 / N 4409 640
(Ca. 1.8 km at azimuth 315 from Hi-Vol Station #8)

06-0580-002 CAMP: 2105 Broadway (a,b,d,e,f,g,h,i)
E 501 120 / N 4399 820
(Ca. 1.1 km at azimuth 025 from Hi-Vol Station #5)

06-0580-009 CARIH: 2095 Julian St. (a,b,c,g,i)
E 497 320 / N 4399 580
(Within 100 m of Hi-Vol Station #96)

06-0580-011 Overland: 2005 South Huron St. (a,b,c,g,i)
E 500 260 / N 4392 040
(Ca. 2.2 km at azimuth 205 from Hi-Vol Station #3)

06-0580-010 National Jewish Hospital: East Colfax Ave. & Colorado Blvd.
E 505 100 / N 4398 580 (a,b,c,g,i)
(Ca. 0.8 km at azimuth 340 from Hi-Vol Station #2)

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a. Coefficient of Haze: Tape Sampler, Transmittance (1120181)
(Data in *COHS/1000 linear ft*; 2-hour intervals)

b. Carbon Monoxide: Non-dispersive Infrared (4210111)
(Data in *ppm*; 1-hour running average data listing)

c. Sulfur Dioxide: Coulometric (4240114)
(Data in *ppm*; 1-hour running average data listing)

d. Sulfur Dioxide: West-Gaeke Colorimetric (4240111)
(Data in *ppm*; 1-hour data listing)

e. Nitric Oxide, NO: Colorimetric (4260111)
(Data in *ppm*; 1-hour data listing)

f. Nitrogen Dioxide, NO_2: Colorimetric (4260212)
(Data in *ppm*; 1-hour data listing)

g. Total Hydrocarbons: Flame Ionization (4310111)
(Data in *ppm*; 1-hour running average data listing)

h. Methane: Flame Ionization (4320111)
(Data in *ppm*; 1-hour data listing)

i. Ozone: Chemiluminescence (4420111)
(Data in *ppm*; 1-hour running average data listing)

Appendix 3. SYNOPSIS OF DATA FROM CONTINUOUS AIR MONITORING STATIONS

Parameter	Arvada	Welby	CAMP	CARIH	Overland	NJH
COH	11/01-30	11/01-30	11/01-30	11/01-30	11/01-30	11/01-30
# Values	355	331	269	354	359	347
Average	0.30	0.61	1.24	0.70	0.58	0.57
Maximum	1.80	3.30	5.80	3.10	2.90	2.40
CO	11/01-30	11/01-30	11/01-30	11/12-30	11/01-30	11/01-30
# Values	643	712	570	448	676	711
Average	3.6	3.6	8.2	5.3	3.8	6.5
Maximum	28.0	22.0	44.0	33.0	33.0	54.0
SO_2	11/01-30	11/01-30	11/01-30	11/01-30	11/01-30	11/01-30
# Values	592	624	430	660	575	573
Average	<.005	.01	.01	.01	.01	.01
Maximum	.06	.07	.10	.07	.16	.05
NO	--	--	11/01-30	--	--	--
# Values			529			
Average			0.11			
Maximum			0.55			
NO_2	--	--	11/01-30	--	--	--
# Values			535			
Average			.05			
Maximum			.22			
Total HC	11/01-30	11/01-30	11/01-30	11/12-30	11/01-30	11/01-30
# Values	542	674	550	373	626	665
Average	3.3	2.9	3.4	3.9	3.3	3.1
Maximum	8.6	9.2	11.4	9.2	9.4	9.4
Methane	--	--	11/01-30	--	--	--
# Values			550			
Average			2.3			
Maximum			7.0			
Ozone	11/01-30	11/01-30	11/01-30	11/01-30	11/01-30	11/01-30
# Values	691	544	513	675	666	649
Average	.014	.013	.007	.012	.012	.008
Maximum	.085	.080	.070	.070	.085	.050

Methods and units of measurement are listed in Appendix 2.

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

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16. ABSTRACT

EPA, university, and private researchers conducted a study of Denver's urban plume during the month of November 1973. The objective of the study was to characterize the pollutants that cause the appearance of the visible colored haze, the so called "Brown Cloud", which frequently occurs over Denver during the fall and winter months. Gaseous and aerosol pollutants, and meteorological parameters were measured periodically under selected conditions.

In March 1975, a symposium was held to present and discuss the results of this study. This report, Volume II, contains important research papers given at the symposium. The papers cover airborne instrument aircraft characterization, optical properties of the plume and airmass movements in the Denver region.

17. KEY WORDS AND DOCUMENT ANALYSIS

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FRONT COVER: Aerial view of Denver from the North looking South at 1100 MST on 21 November 1973. The central business district can be seen in the upper left quadrant. Note the bright appearance of the urban plume and compare with photograph below.
Photography by: Charles E. Grover
Denver, Colorado

Aerial view of Denver from the South looking North at 1120 MST on 21 November 1973. The central business district is located slightly to the right of center, one-fourth down from top. Note the dark brown appearance of the urban plume.
Photography by: Charles E. Grover
Denver, Colorado