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Manometer Report I: Manometric Calibrations of Primary Reference Gases During 1969 and 1970

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Manometer Report I:

Manometric Calibrations of Primary Reference Gases During 1969 and 1970

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Preface

Manometer Report I, summarizing the manometric reference gas calibrations carried out in 1969 and 1970, was originally prepared in 1970. It is presented here unchanged, aside from retyping and minor changes in format and nomenclature in order to more closely follow that in subsequent reports. The calibration results were calculated by a preliminary procedure using the 1959 and 1961 manometric volume ratio and therefore differ significantly from results calculated using the current volume ratio and procedures. To underscore this difference, the calibration results summarized in Tables 1, 2 and 6 and depicted in Figure 3 are termed partial pressures instead of mole fractions.

The appendix to Manometer Report I presents the original data and results of 1969-70 in the identical format used in Manometer Reports II and III. The calibration results or mole fractions reported in the appendix were calculated using the current procedure, first used in 1972, with the manometric volume ratio determined in 1974. Only the calibration results listed in the appendix can be compared to the results of 1972 and 1974. See Manometer Report III for details of the calculation procedure and Manometer Report IV for the determination of the manometric volume ratio used to calculate the results in the appendix.

I. Introduction

The CO_2 Project at Scripps Institution of Oceanography maintains an extensive series of reference gases (of close to atmospheric concentrations of CO_2 in N_2), to which all measurements of atmospheric and oceanic carbon dioxide and total carbon are related. To a first approximation, these reference gases are assigned index values, pseudo concentrations - expressed in ppm CO_2 of dry mixture - that are linearly related to their observed scale differences on the infrared analyzer. The index value of a reference gas is determined by a series of comparisons on the infrared analyzer with standard reference gases. The REFGAS system is internally consistent back to the beginning of the project in 1958.

The true partial pressure of CO_2 in dry mixture, however, is not linearly related to the observed scale difference on the analyzer. Calibration of the index value system is accomplished by absolute determination of the CO_2 partial pressure of reference gases on a precision constant volume manometer located in Room 2317, Ritter Hall. Such calibrations were carried out in 1959 and again in 1961 by C. D. Keeling.

During November, 1969, C. D. Keeling and P. R. Guenther initiated a new series of calibrations. The following report summarizes twenty-seven calibration runs on four selected reference gases plus associated studies carried out from November 1969 to May 1970. This work constitutes "Phase I" of the new calibration series.

II. Experimental Procedures

The calibration apparatus consists of the constant volume manometer

in its insulated cabinet, the connected high vacuum system ("isotope rack"), the infrared analyzer and connecting tubing, and a precision cathetometer to measure mercury levels in the manometer. The following notes describe the experimental procedures followed for the calibration runs. No attempt is made here to fully describe the apparatus.

A. Passage of Reference Gas into Large Manometer. On the day before a given run, the reference gas to be determined is passed directly through the infrared analyzer until a steady trace is obtained. Then the gas is passed through the manometer connecting tubing until the trace is again steady and identical to the direct trace. The manometer line is closed off and the gas again passed directly through the analyzer. On the day of analysis, the above procedure is repeated with careful attention to any leaks in the connecting lines, observable as a "blip" on the analyzer trace after beginning passage of gas through the manometer line. The large volume (5000 cc) manometer and connecting manifolds are also carefully checked for leaks with vacuum gauges after being pumped to a high vacuum (better than 1 micron). If all is well, approximately 2 cm of gas is passed into the large manometer through a dry ice trap to remove water and then pumped out again. Finally, about 58 cm of the reference gas is passed into the large colume. The sample is then confined in this volume, and the air circulation fans in the cabinet are turned on.

B. Large Volume Pressure Measurement. After waiting about one hour for temperature equilibration, the mercury level is brought above and then back below the 5000 cc pointer. The mercury is then slowly raised

to $\leq$ 300 microns from the pointer for the required accuracy. The pointer cannot be approached much closer than 300 microns because the mercury begins to bulge toward the pointer, perhaps even prematurely touching it, making measurement of the height very difficult. When the mercury level is stable, the sample column (No. 5 on Fig. 2) height is measured. The vacuum column (No. 8 on Fig. 2) height is then measured, followed by the sample column again. In all cases a measurement consists of the average of two readings. If the second sample column measurement is significantly different from the first, the measurements are repeated until constant values are obtained. During these measurements, thermometer No. 6112 is also read several times. At the end of the measurements, all seven cabinet thermometers are read (see Table 4 and Fig. 2). The temperature of No. 6112 is used as the temperature of the large volume.

C. Extraction. The vacuum lines are carefully checked for leaks. If all is well, the carbon dioxide is extracted from the reference gas in the large manometer by slowly pumping it through a spherical trap filled with liquid nitrogen. The speed of the extraction is expressed by the pressure of the gas flowing through the trap. This pressure is maintained at about 1.0 cm of mercury. The maximum pressure for individual runs in Phase I ranged from 0.8 to 3.5 cm (momentary maximum). Although no correlation between extraction rate and partial pressure of CO_2 is found in the available data, a systematic investigation of the spherical trap efficiency will be made in Phase II. Extraction is continued until the pressure gauges indicate all of the gas in the large

manometer has passed through the trap.

D. Transfers. The extracted carbon dioxide (plus any residual water) is transferred to a U-trap in liquid nitrogen by warming the spherical trap with a heat gun. The sample is then moved into the small 4 cc manometer by a series of four transfers accomplished by cooling the second trap to liquid nitrogen temperature and then warming the first trap to dry ice or liquid/solid ethanol temperature. In this way, residual water is separated from the CO_2. For the first transfer from the spherical trap and for the following two transfers, the system is also pumped through the liquid nitrogen trap after the bulk of the transfer has taken place according to the vacuum gauge. After the transfer, the U-trap can be tested for residual condensable gas by warming it to room temperature and observing the vacuum gauge. The sample always tested clean after the second transfer. Table 2 summarizes the transfer times and the trap material (dry ice or liquid/solid ethanol) used for the transfers.

In addition to the usual vacuum gauge leak tests, a further check of the vacuum in the small manometer is made by raising the mercury all the way to the top of column No. 4 before the final transfer. The manometer functions here as a McLeod guage - the size of the remaining bubble, if any, indicates the degree of vacuum. This test is more sensitive than the Autovac vacuum gauge. For most runs, no bubble at all remains in the tube - the mercury "sticks" when it is lowered. At worst a very small bubble remains (the difference between these two conditions is not observable on the Autovac).

After the sample is in the manometer, it is confined and thawed into gas. The cabinet fans are turned on.

E. Small Volume Pressure Measurement. After allowing about one hour for temperature equilibration, the mercury is brought above and then back below the 4 cc pointer. The mercury is then very slowly and carefully raised to the pointer. The pointer is approached as closely as possible without contact being made with the mercury. The sample column (No. 4 on Figure 2) height is measured, followed by the vacuum column (No. 2 on Figure 2) height. The sample column is again measured as a check. The mercury is then raised until it just makes contact with the pointer, the sample column is measured, and finally the vacuum column is measured. The recorded values of the mercury heights are the averages of the before contact/after contact measurements on both the sample and the vacuum columns. On a good run the sample column readings are 10 to 20 microns apart, and the vacuum column readings are about 100 microns apart.

The temperature of the run is read on thermometer No. 6112.

F. Reruns. During Phase I, reruns of the CO_2 pressure on the small manometer were made after transferring the sample out to trap U-1 in one step and then back into the manometer in two steps via trap U-R-4. The purpose of these reruns was to test the transfer efficiency. Table 2 summarizes the rerun data. In all cases the transfer time out of the manometer to trap U-1 was longer than the listed rerun transfer time for the in transfers. For those reruns with transfer times of one minute, the transfer out to U-1 was accomplished in five minutes. At least three minutes was required for the bulk of the transfer out to

occur according to the vacuum gauge in the transfer path. The manometer was then pumped for two minutes through trap U-1. The transfers back into the manometer (one minute each) were accomplished as described in section D.

G. Meniscus Corrections. Before and after a series of runs, meniscus corrections are determined for the small volume manometer, where the sample column is of a smaller diameter than the vacuum column. Corrections are also determined for the large volume manometer - these reflect the non-level swing of the cathetometer scope.

For the small manometer corrections, Col. No. 4 and Col. No. 2 are pumped to a high vacuum while connected to each other by the manometer manifold in the cabinet. The system is closed off from the pump and tested for leaks ("bubble test" as in Section D). The mercury level is then brought up near the pointer. The meniscus corrections in Phase I were measured at varying distances from the pointer. The correction seemed to increase as the mercury approached the pointer. Measurements seemed to be most valid at about 50 microns from the pointer, also about the closest possible approach before the mercury began to bulge toward the pointer.

For the large volume corrections, a small amount of reference gas (about 2 cm of mercury) is introduced into Col. No. 5 and Col. No. 8, connected to each other by the manometer manifold, so that the mercury level can be lowered below the 5000 cc pointer. Measurements are made with the mercury at the fifth fiducial mark, very close to the mercury level during the large volume measurements.

The meniscus corrections are summarized in Table 3.

H. Calculation of CO_2 Partial Pressures. The data obtained above (pressure of the entire gas sample at X^oC, pressure of the CO_2 content at Y^oC and the meniscus corrections) are combined with the volume ratio of the 5000 cc and 4 cc volumes (1319.752 - determined in 1959) and with corrections for nonideality to obtain the partial pressure of CO_2 in the sample. A computer program (CALTANK) exists for these calculations, but has not been used for the new calibrations because the method of calculation must be reviewed. In the meantime partial pressures (see Table 1 and Table 6) are calculated using a "fictitious volume ratio" that incorporates the corrections for nonideality, assuming they are very close for all of the reference gases (1313.5 - consistent with the 1959 calibrations). The equation used is the following:

$$\begin{matrix} CO_2 \text{ Partial} \\ \text{Pressure} \\ \text{in ppm} \end{matrix} = \frac{\begin{matrix}\text{Corr'd pressure of } CO_2 \text{ in small manometer at } 300^oK \\ \text{Corr'd pressure of total gas in large manometer} \\ \text{at } 300^oK\end{matrix}}{} \times 761.30$$

III. Results: Data Presented in Tables and Figures

A. Table 1. Data required for calculation of the twenty-seven calibration runs and their reruns is presented in Table 1. Also included are the CO_2 concentrations or partial pressures calculated as explained in Part II, Section H. Data are not presented for runs 1 through 5, as these "debugging" runs yielded anomalous results that are omitted from the averages. Manometer column numbers are defined on Figure 2. Meniscus corrections are discussed below and summarized in Table 3 and Figure 1. The listed temperatures are those of thermometer No. 6112 plus 273.16^oK.

B. Table 2. Details on transfers and reruns are presented in Table 2. For most runs, the transferring trap mixture was a dry ice/2-butoxy ethanol slush (temperature = $-78^{\circ}C$). On some earlier runs (Nos. 6 to 10, 12, 13), a liquid/solid ethanol slush (temperature = $-117^{\circ}C$) was used in order to confirm that the finite vapor pressure of water ice at $-78^{\circ}C$ (about 1/2 micron) was not interfering in runs with long (greater than ten minutes) transfer times (for example, in the anomalous Runs 1 to 5). While a lack of CO_2/water separation and consequent high partial pressures may have occurred in these runs, the data show no such effect for long and short transfer times with liquid/solid ethanol or for short transfer times with dry ice.

Calculated rerun partial pressures show that transfer times of one minute are adequate for complete transfer. Although most rerun partial pressures show a decrease, the amount of the decrease does not correlate with the rerun transfer times. Rerun transfer times of less than one minute (in order to find a time so short that complete transfer does not occur) were not attempted for the following reasons: (1) One minute is about as fast as a transfer can conveniently be accomplished, and (2) the limit seems to be approximately one minute anyway. The Autovac pirani tube is in the transfer path for the second rerun transfer (from U-R-4 into the manometer). Only one small stopcock must be passed on the way. The time for complete recovery of the Autovac gauge was about 45 seconds. There is no vacuum gauge in the transfer path, however, for the first rerun transfer (U-1 to U-R-4); furthermore, three small stopcocks must be passed on the way. It is

thus reasonable to expect this transfer to be the slower of the two. Hence one minute is a reasonable lower limit for transfer times. At any rate, transfer times of one to three minutes using a dry ice slush appear to be entirely adequate for complete transfer and for CO_2/water separation.

C. Table 3, Figure 1. The meniscus correction studies made during Phase I are summarized in Table 3. Of these, four pairs of corrections were used in calculating the partial pressures for the runs. For the small manometer, these corrections vary considerably: -.430 for runs 1 to 13, -.384 for runs 14 to 16, -.330 for runs 17 to 20, and -.444 for runs 21 to 27. Comparison of the run results, however, does not show a correlation with the meniscus correction used (a 0.10 mm error in the small manometer correction should cause an inverse 0.10 ppm error in the partial pressure).

An important factor in the magnitude of the small volume meniscus correction is the distance of the mercury level from the sample column pointer. As the mercury approaches the pointer, the correction increases. This may be due to an actual depression of the mercury by the pointer (electrostatic?) or to an optical effect due to the difference in meniscus illumination by the meniscus reader. It was decided to investigate the distance factor somewhat.

Figure 1 is a plot of the observed small manometer meniscus corrections versus the distance of the mercury from the 4 cc pointer. The data are taken from Table 3. In most cases the pointer height was measured during the determination - the distance of the mercury from the pointer was thus

directly determined. In a few cases where the pointer height was not measured, the distance was estimated from adjacent runs (distance from pointer in parentheses for these cases). If the mercury was moving, an average distance is plotted.

Figure 1 displays at least a rough correlation of distance from the pointer with magnitude of the meniscus correction. A least squares reduction of the data (all sixteen determinations weighted equally) is drawn. The least squares line yields a meniscus correction of -.423 mm at 0.05 mm from the pointer or -.458 mm at the pointer (mercury bulging effects eliminated).

(If the relationship is approximately linear, Figure 1 suggests a way of accurately determining the small manometer meniscus correction. A series of perhaps ten determinations of the correction at varying distances from the pointer (for example from 300 microns to 50 microns) could be made and then plotted versus the distance from the pointer. As it is difficult to directly measure the height of the pointer tip, it would probably be more accurate to plot the values versus the sample column height and to use the average before/after contact reading of column No. 4 from calibration runs as the level of the pointer.)

No such problems occur with the large volume corrections. The meniscus corrections and the final large manometer sample column measurements are made at the same height or distance from the pointer - at about the 5th fiducial mark or 300 microns below the pointer. The correction here is due to the non-level swing of the cathetometer scope from column No. 5 to 8. Changes in the correction caused by releveling the cathetometer

are very apparent in Table 3. Since the large volume measurements are less critical, the corrections are also less critical; and the fact that they cannot be determined as accurately (due to poor illumination of Column No. 8 meniscus) is inconsequential.

D. Table 4, Figure 2. Table 4 presents the temperatures read on the cabinet thermometers immediately following measurement of the large manometer pressure for each run. The observed temperature of thermometer No. 6111 is listed, along with the corrected deviations of the other six thermometers from it (the observed temperatures are first adjusted by the corrections listed in Table 4). Figure 2 diagrams the placement of the thermometers in the manometer cabinet.

The observed (uncorrected) temperature of thermometer No. 6112 is used as the temperature for both the large and the small manometer pressure measurements. For the latter, this temperature is as valid as possible since the thermometer is located very near the 4 cc manometer. The closest thermometers to the large manometer, however, are Nos. 6113, 6115 and 6117; and these are on the average .01° to .03°C lower than No. 6112. This difference would lead to the calculated partial pressures being from .01 to .03 ppm too high.

Placement of the lower baffle board in the cabinet is seen to have improved the air circulation in the cabinet somewhat (that is, lowered the cabinet temperature gradients slightly).

E. Table 5. The infrared analyzer runs made on the four tanks calibrated in Phase I are summarized in Table 5. The data listed for tank 7366 need some explanation. For those runs designated with +, the

recorder scale factors were determined in the usual way from the difference between the primary and high span standards. For the runs designated with a°, the recorder scale factors were determined from the difference between the primary and low span standards. The results of these two methods show a difference of almost one part per million. They should yield the same result since the low span standard was originally determined by extrapolation, using the high span recorder scale factor and comparison with higher tanks. Since that time, however, the low span standards have slipped or an instrumental change has occurred. It happens that the high span value correlates better with the other Phase I calibrations (see below). This "low span problem" is in the process of being rectified. As part of the solution, tank 7366 will be better determined with about 100 comparisons.

F. Table 6, Figure 3. In Table 6 and Figure 3 the analyzer calibration obtained from the Phase I results is compared with the 1959 manometric calibration and with the 1968 gravimetric calibration done by C. S. Wong. Figure 3, the calibration curve for the analyzer, shows the curvature of the new calibration as compared with the linear 1959 calibration. The differences Partial Pressure-Gravimetric show that a nearly constant value (average of 3.13 ppm over the four gases) separates the new curve from the Wong calibration - the curvature is the same but the absolute value is different. The explanation for this difference is not yet known; a thorough review and comparison of Wong's method and the new method is required.

The Partial Pressure-Gravimetric differences for tank 7366 lend circumstantial evidence that the index values derived using a high span recorder scale factor are more nearly correct. Calibration of additional low span tanks is necessary before this problem is solved. Initiating a new low span standard determined using high span recorder scale factors will be the basis of the solution.

IV. Discussion of Errors

The manometric calibration method was originally expected to be capable of delivering a precision of one part in ten thousand. The data in Table 6 shows that the Phase I calibration runs at best reached a precision of about one part in 5000 - equivalent to a precision of .06 ppm for a typical reference gas of 300 ppm. The standard deviations reported in Table 6 range from .05 (only three runs) to .20 ppm. Perhaps more indicative of the error problems encountered are the two high runs on tank 2399 (run Nos. 9 and 16) - these cannot be explained by any experimental variable. In the following discussion error magnitudes are assigned to various possible sources. Systematic errors that affect all of the Phase I data will not be considered (e.g. volume ratio errors).

Errors in measurement of the mercury levels are of prime interest. As discussed in Section II E, the recorded small manometer measurements are averages of adjacent before contact/ after contact measurements. With all of the cabinet fans on to afford adequate air circulation, the closest possible approach to the pointer results in a difference of about 100 microns between the before contact and after contact readings

on the vacuum column (this is possible unless a certain infrequent - and unexplained - high frequency vibration is present). The recorded measurement of mercury height when it just makes contact with the pointer is the average of these two readings. Under these conditions, a maximum error might reasonably be ± 50 microns which, for the most susceptible gases (low spans), could yield an error of one part in four thousand or between .05 and .10 ppm in the result. However, the consistency of reruns with first runs seems to indicate that this factor does not appreciably contribute to the difference between separate runs on a particular gas.

In the large volume measurements, the mercury level is brought to within 300 microns of the pointer and then the columns are measured. A cylinder with a height of 300 microns in the large manometer column cuts off a volume of about 140 mm^3 out of a total of 5000 cc. The pressure of this amount of gas could amount to .02 mm, or perhaps .01 ppm in the result. This would seem to be an insignificant error source.

As discussed in Section III C, meniscus corrections for the small manometer may be in error by as much as 0.100 mm. A 0.10 ppm error in the results could be attributed to this source, although evidence of this effect could not be found in the data (comparison between calculations using different meniscus corrections). The error here can definitely be improved by determining the meniscus corrections more carefully, perhaps as suggested in section III C. The meniscus corrections for the large volume manometer may be in error by ±.02 mm, leading to an insignificant error of ±.01 ppm in the result.

The cabinet temperature gradients could cause an error of .03 ppm in the result, as discussed in Section III D. Table 4 indicates, however, that the gradients are nearly identical for all the runs - hence this error source would affect all of the runs systematically.

Another possible error source is actual gains or losses of sample during extraction and transfer (volumetric errors). As discussed in Section II C, the available extraction data do not indicate the possibility of incomplete extraction, although a thorough investigation of this factor will be made in the Phase II studies. Furthermore, tests indicated that water vapor was effectively removed from the sample. Finally, the excellent rerun results down to transfer times of one minute indicate that complete transfer of the sample is accomplished. Any errors attributable to these volumetric sources would seem to be on the order of less than one part in ten thousand.

Errors due to the cathetometer "jumping" or moving are a possibility. These can be observed as differences between closely spaced measurements of an identical fiducial mark. The maximum difference observed was .02 mm, which could lead to an error of .03 ppm in the result.

The conclusion of this error discussion would have to be that precise identification of error sources in not possible at this time. Hopefully, after further work, either the precision of the work will improve or more detailed information on errors will be available.

V. Future Plans

The primary accomplishment of the Phase I studies is the bare outline of a new calibration curve for the infrared analyzer. Also of

great importance are the development and testing of measurement procedures.

The next phase of work will involve modifications of the apparatus. A glassblower will be retained to replace several small stopcocks in the transfer lines with larger ones, to replace the existing thermocouple gauges with three more Autovac vacuum gauge tubes, and to repair a few odds and ends. The air circulating fans will be checked out in an attempt to further reduce the vibrations. An attempt will be made to eliminate the slight leak in the upper manifold. Finally, many stopcocks will have to be regreased and extensive leak tests made.

Phase 2 studies will include tests of the extraction efficiency (extraction at various speeds through the spherical trap) and some additional transfer tests (reaching a rerun transfer time too short for complete transfer and running several "round trip" transfers). Of necessity, these experiments will be performed on previously determined gases, probably 6078 and 2399. All four Phase I gases will be run at least once to check reproducibility with Phase I runs. Finally, calibration of a very high (index value 372 ppm) and a very low (index value 254 ppm) gas will be made to further define the Partial Pressure-Gravimetric relationship. Final CALTANK calculations of all runs up to this point should also be possible by this time.

The experience and results of these first two phases will be applied during Phase III in attempts to reach the ultimate precision possible for the method. The long term reference gases of the CO_2 project should also be run during this time in order to fill out the calibration curve

and to afford additional evidence concerning their long-term stability.

Phase IV will probably involve extensive calibration and recalibration of the manometer volume ratios and calibration of additional selected reference gases to fill in the calibration curve.

Table 1. Phase I Data Summary

Run No.	Date	Reference Gas Cylinder No.	Location in Original Data Book II	Manometer*	Hg Height in Vacuum Column** (mm)	Hg Height in Sample Column*** (mm)	Meniscus Correction (mm)	Temp. (°K)	Corrected Pressure at 300°K (mm)	Partial Pressure of CO_2 in N_2*** (ppm)
1	25 Nov 69	6078	Part 3, p 98							313.02
2	26 Nov 69	6078	107							312.09
3	27 Nov 69	6078	115	Samples 1-5 are "debugging" runs						314.28
4	28 Nov 69	6078	121							315.93
5	28 Nov 69	6078	125							unfinished
6	1 Dec 69	6078	135	Large	772.173	177.232	-.070	293.31	608.439	
			140	Small	618.844	374.697	-.430	293.17	249.395	312.05
			144	Small-rerun	618.899	374.646	-.430	293.25	249.435	312.10
7	2 Dec 69	6078	141	Large	769.870	177.252	-.070	293.07	606.560	
			146	Small	618.124	374.682	-.430	293.07	248.758	312.22
			150	Small-rerun	618.472	374.684	-.430	293.40	248.832	312.31
8	3 Dec 69	2399	149	Large	766.602	177.249	-.070	293.45	602.498	
			Part 4, p 1	Small	626.890	374.694	-.430	293.37	257.456	325.31
			5	Small-rerun	629.996	374.678	-.430	293.74	257.256	325.06
9	4 Dec 69	2399	3	Large	777.489	177.274	-.070	293.56	613.311	
			8	Small	631.857	374.685	-.430	293.46	262.464	325.80
			9	Small-rerun	631.688	374.693	-.430	293.39	262.345	325.65
10	8 Dec 69	6078	14	Large	768.700	177.370	-.070	293.05	605.282	
			18	Small	617.370	374.774	-.430	293.04	247.918	311.82
			19	Small-rerun	617.566	374.779	-.430	293.23	247.859	311.75
11	9 Dec 69	6078	17	Large	767.572	177.315	-.070	292.84	604.617	
			23	Small	616.716	374.621	-.430	292.42	247.929	312.18
			25	Small-rerun	617.249	374.620	-.430	293.15	247.858	312.09

Table 1. Phase I Data Summary (con't)

Run No.	Date	Reference Gas Cylinder No.	Location in Original Data Book II	Manometer*	Hg Height in Vacuum Column** (mm)	Hg Height in Sample Column*** (mm)	Meniscus Correction (mm)	Temp. (°K)	Corrected Pressure at 300°K (mm)	Partial Pressure of CO_2 in N_2*** (ppm)
12	10 Dec 69	10069	Part 4, p. 26	Large	771.326	177.243	-.070	293.11	607.976	
			29	Small	652.387	374.613	-.430	291.91	285.030	356.91
			32	Small-rerun	653.019	374.594	-.430	292.69	284.938	356.80
13	11 Dec 69	6078	31	Large	774.840	177.182	-.070	292.55	612.806	
			35	Small	620.472	374.621	-.430	293.02	251.267	312.15
			36	Small-rerun	620.165	374.629	-.430	292.78	251.150	312.01
14	9 Mar 70	6078	44	Large	764.348	173.649	-.127	292.46	605.798	
			47	Small	613.548	371.014	-.384	292.35	248.486	312.27
			50	Small-rerun	613.381	370.996	-.384	292.29	248.384	312.14
15	10 Mar 70	2399	49	Large	760.504	173.657	-.127	292.30	602.176	
			54	Small	622.094	371.019	-.384	292.35	257.251	325.23
			56	Small-rerun	622.165	370.994	-.384	292.42	257.288	325.28
16	12 Mar 70	2399	57	Large	764.160	173.552	-.127	292.41	605.808	
			60	Small	624.113	371.014	-.384	292.52	259.177	325.70
			61	Small-rerun	624.028	371.001	-.384	292.48	259.139	325.65
17	23 Apr 70	2399	86	Large	773.375	173.374	-.104	293.20	613.810	
			91	Small	627.755	370.962	-.330	293.32	262.304	325.33
			94	Small-rerun	627.410	370.948	-.330	293.04	262.215	325.22
18	24 Apr 70	10069	95	Large	766.329	173.512	-.104	293.04	606.791	
			98	Small	649.408	370.963	-.330	293.19	284.575	357.04
			99	Small-rerun	649.137	370.943	-.330	293.02	284.483	356.92
19	27 Apr 70	10069	103	Large	771.880	173.519	-.104	292.70	613.178	
			107	Small	651.634	370.944	-.330	292.72	287.333	356.74
			109	Small-rerun	651.895	370.964	-.330	292.87	287.432	356.87

Table 1. Phase I Data Summary (con't)

Run No.	Date	Reference Gas Cylinder No.	Location in Original Data Book II	Manometer*	Hg Height in Vacuum Column** (mm)	Hg Height in Sample Column*** (mm)	Meniscus Correction (mm)	Temp. (°K)	Corrected Pressure at 300°K (mm)	Partial Pressure of CO_2 in N_2**** (ppm)
20	28 Apr 70	2399	Part 4, p.108	Large	762.994	173.472	-.104	292.76	603.994	
			113	Small	622.990	370.970	-.330	292.56	258.091	325.31
			115	Small-rerun	623.235	370.973	-.330	292.84	258.092	325.31
21	11 May 70	7366	124	Large	759.159	173.600	- - -	292.96	599.630	
			127	Small	585.092	370.982	-.444	293.14	218.666	277.62
			131	Small-rerun	584.772	371.005	-.444	292.83	218.546	277.47
22	12 May 70	7366	132	Large	765.191	173.633	- - -	292.82	606.063	
			134	Small	587.199	370.962	-.444	292.81	221.092	277.72
			135	Small-rerun	587.418	370.971	-.444	293.07	221.111	277.75
23	12 May 70	7666	136	Large	768.269	173.495	- - -	293.10	608.776	
			138	Small	588.257	370.974	-.444	292.90	222.095	277.74
			142	Small-rerun	588.190	370.949	-.444	292.91	222.045	277.68
24	13 May 70	2399	140	Large	764.344	173.561	- - -	292.82	605.259	
			144	Small	624.333	370.965	-.444	293.25	258.746	325.45
			145	Small-rerun	623.965	370.947	-.444	292.84	258.749	325.46
25	14 May 70	10069	146	Large	760.347	173.545	- - -	292.83	601.170	
			148	Small	646.598	370.962	-.444	292.89	281.872	356.95
			149	Small-rerun	646.910	370.969	-.444	293.21	281.877	356.96
26	14 May 70	6078	150	Large	762.000	173.492	- - -	293.25	602.054	
			152	Small	612.586	370.988	-.444	292.89	246.988	312.33
			Part 5, p. 3	Small-rerun	612.607	370.976	-.444	292.97	246.974	312.30
27	15 May 70	2399	5	Large	762.927	173.588	- - -	293.01	603.398	
			7	Small	623.445	370.956	-.444	293.33	257.776	325.23
			8	Small-rerun	623.625	370.949	-.444	293.60	257.730	325.17

NOTES:

* Large = Large Manometer (~5000cc) Total Gas Pressure, $CO_2 + N_2$

Small = Small Manometer (~4cc) CO_2 Pressure

Small-rerun = Rerun on Small Manometer CO_2 Pressure

** Vacuum Column is Col. No. 8 for L and No. 2 for S

*** Sample Column is Col. No. 5 for L and No. 4 for S

**** Calculated using "fictitious volume ratio" Conc = $\frac{\text{Corr'd. Pressure of Small Mano.}}{\text{Corr'd. Pressure of Large Mano.}} \times 761.30$

Table 2. Transfer Times and Reruns

Cylinder No.	Run No.	Trap Mixture	1st Run Transfer Times (min.)	Rerun Transfer Times (min.)	1st Run Partial Pressure (ppm)	Rerun Partial Pressure (ppm)	Rerun Difference (ppm)
6078	6	Liq-Solid Ethanol	10	20	312.05	312.10	+.05
	7	L-S Eth	15-20	10	312.22	312.31	+.11
	10	L-S Eth	10	5	311.82	311.75	-.07
	11	dry ice	3-4	4	312.18	312.09	-.09
	13	L-S Eth	5-6	3	312.15	312.01	-.14
	14	dry ice	5-7	2	312.27	312.14	-.13
	26	dry ice	3	1	312.33	312.30	-.03
2399	8	L-S Eth	10-17	10	325.31	325.06	-.25
	9	L-S Eth	10	10	325.80	325.65	-.15
	15	dry ice	5	2	325.23	325.28	+.05
	16	dry ice	5-8	1	325.70	325.65	-.05
	17	dry ice	5-22	1	325.33	325.22	-.11
	20	dry ice	5-8	1	325.31	325.31	.00
	24	dry ice	3	1	325.45	325.46	+.01
	27	dry ice	3	1	325.23	325.17	-.06
10069	12	L-S Eth	5-6	5-6	356.91	356.80	-.11
	18	dry ice	4-5	1	357.04	356.92	-.12
	19	dry ice	5-6	1	356.74	356.87	+.13
	25	dry ice	3	1	356.95	356.96	+.01
7366	21	dry ice	5	1	277.62	277.47	-.15
	22	dry ice	5	1	277.72	277.75	+.03
	23	dry ice	5	1	277.74	277.68	-.06

Small Manometer

Date	Approx. Distance from Hg to Pointer (mm)	Number of Determinations	Average Sample Column Height (mm)	Average Vacuum Column Height (mm)	Applied Correction (mm)	Comments
21 Nov 69	.07-.01	6	374.603	375.021	-.418	
27 Nov 69	.05	4	374.615	375.045	-.430	Value used for Runs 1 to 13
8 Dec 69	.115-.070	10	374.726	375.136	-.411	Start at 5th Fiducial Mark
12 Dec 69	.133-.073	10	374.528	374.891	-.363	Start at 5th F-mark, Hg slightly bulging
			(releveled cathetometer)			
9 Mar 70	(.191)	10	370.821	371.180	-.359	At 5th F-mark
13 Mar 70	.100	10	370.912	371.319	-.409	Av. = -.384 used for Runs 14 to 16
22 Apr 70	(.111)	5	370.883	371.292	-.409	At 5th F-mark
23 Apr 70	.278	5	370.716	370.992	-.276	Just below 5th F-mark
23 Apr 70	.110	5	370.884	371.231	-.346	Just above 5th F-mark
27 Apr 70	.212	3	370.788	371.061	-.272	Just below 5th F-mark
27 Apr 70	.20-.10	5	370.857	371.146	-.289	Hg moving-bulging toward pointer
27 Apr 70	.158	4	370.842	371.163	-.321	Just above 5th F-mark
27 Apr 70	.183	3	370.787	371.109	-.322	Just above 5th F-mark
30 Apr 70	(.205)	3	370.765	371.119	-.355	Just below 5th F-mark
						Av. = -.330 used for Runs 17-20
			(releveled cathetometer)			
6 May 70	.03-.04mm	10	370.938	371.348	-.410	Slight bulging of Hg
18 May 70	.06	10	370.920	371.397	-.477	Av. =-.444 used for Runs 21-27

Table 3. Meniscus Corrections (con't)

Large Manometer

Date	Approx, Distance from Hg to Pointer (mm)	Number of Determinations	Average Sample Column Height (mm)	Average Vacuum Column Height (mm)	Applied Correction (mm)	Comments
25 Nov 69	.20	4	177.310	177.371	-.061	All roughly at 5th F-mark unless otherwise noted
27 Nov 69		11	176.156	176.226	-.070	Value used for Runs 1-13
8 Dec 69	.3-.1	6	177.402	177.438	-.036	Hg moving
12 Dec 69	.22	10	177.162	177.188	-.026	
			(releveled cathetometer)			
9 Mar 70	.20	10	173.622	173.750	-.127	Av. = -.127 used for Runs 14-16
13 Mar 70	.28	10	173.524	173.649	-.126	
22 Apr 70		10	173.519	173.623	-.104	Value used for Runs 17-20
29 Apr 70		3	173.542	173.656	-.114	
30 Apr 70		3	173.553	173.665	-.112	
5 May 70		3	173.566	173.669	-.103	
			(releveled cathetometer)			
6 May 70		10	173.527	173.541	-.014	Av. = 0.000 used for Runs 21 to 27
15 May 70	.20	10	173.512	173.498	+.015	Above 5th F-mark - no bulging

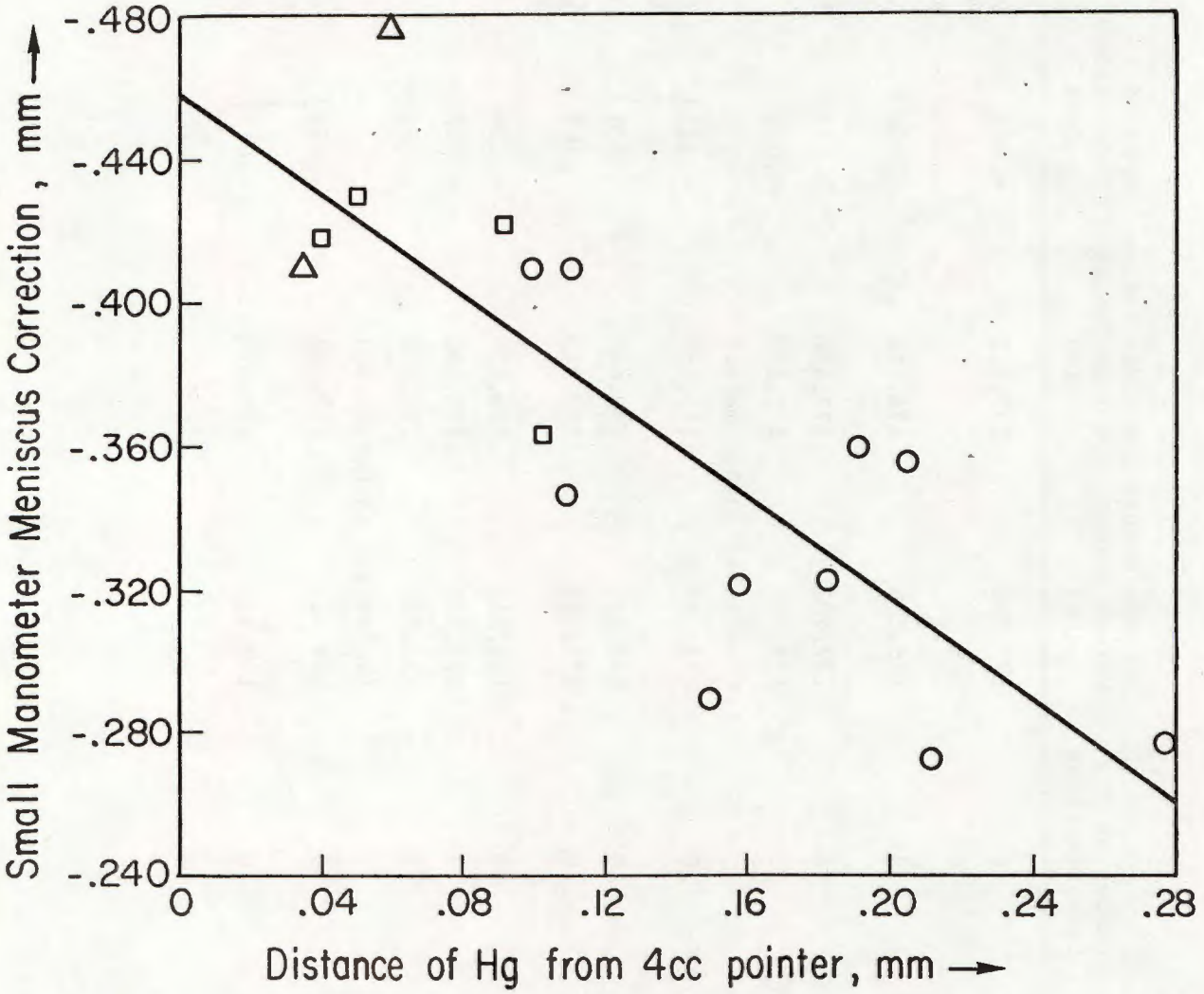


Figure 1. Small Manometer Meniscus Corrections Plotted Versus the Distance of the Mercury Column from the Pointer. The squares represent the corrections measured from 21 November to 12 December 1969, the circles those measured from 9 March to 30 April 1970 and the triangles those measured on 6 May and 18 May 1970.

Table 4. Manometer Cabinet Temperature Gradients*

Run No.	Date	Corrected** Deviations of Thermometers from No. 6111 in °C							Comments
		6114	6113	6111	6112	6115	6117	6116	
1	25 Nov 69	-.02	-.04	20.07	-.01	-.03	-.04	.00	Bottom baffle board not in
		-.02	-.05	20.09	-.01	-.03	-.04	-.01	place for Runs 1 to 13
2	26 Nov 69	-.02	-.05	20.18	-.01	-.01	-.06	-.01	
3	27 Nov 69	-.06	-.05	20.25	-.02	-.02	-.04	-.02	
4	28 Nov 69	-.02	-.04	19.90	-.01	-.01	-.03	-.01	
		-.03	-.04	19.96	-.01	-.03	-.05	-.01	
7	2 Dec 69	-.02	-.04	19.92	-.01	-.02	-.05	-.01	
8	3 Dec 69	-.01	-.04	20.30	.00	-.01	-.03	.00	
9	4 Dec 69	-.01	.04	20.42	-.01	-.01	-.03	-.01	
10	8 Dec 69	-.04	-.05	19.93	-.02	-.05	-.07	-.01	Only middle and outer fans on
11	9 Dec 69	-.02	-.07	19.73	-.02	-.02	-.03	.00	
12	10 Dec 69	-.03	-.05	19.97	-.02	-.04	-.06	-.02	
13	11 Dec 69	.00	-.02	19.44	-.02	-.02	-.05	+.03	Only middle and outer fans on
	Averages	-.02	-.04		-.01	-.02	-.04	-.01	
14	9 Mar 70	+.01	-.04	19.30	-.01	-.02	-.06	+.02	Bottom baffle board in place
15	10 Mar 70	+.04	.00	19.12	+.02	+.01	-.03	+.03	for Runs 14 to 27
16	12 Mar 70	+.01	-.02	19.26	-.01	-.02	-.04	+.01	
17	23 Apr 70	.00	-.05	20.04	-.01	-.03	-.04	+.01	
18	24 Apr 70	-.01	-.04	19.89	.00	-.01	-.05	+.01	
19	27 Apr 70	.00	-.04	19.56	-.01	-.03	-.04	.00	
20	28 Apr 70	.00	-.03	19.61	-.01	-.02	-.04	.00	

Table 4. Manometer Cabinet Tmperature Gradients* (con't)

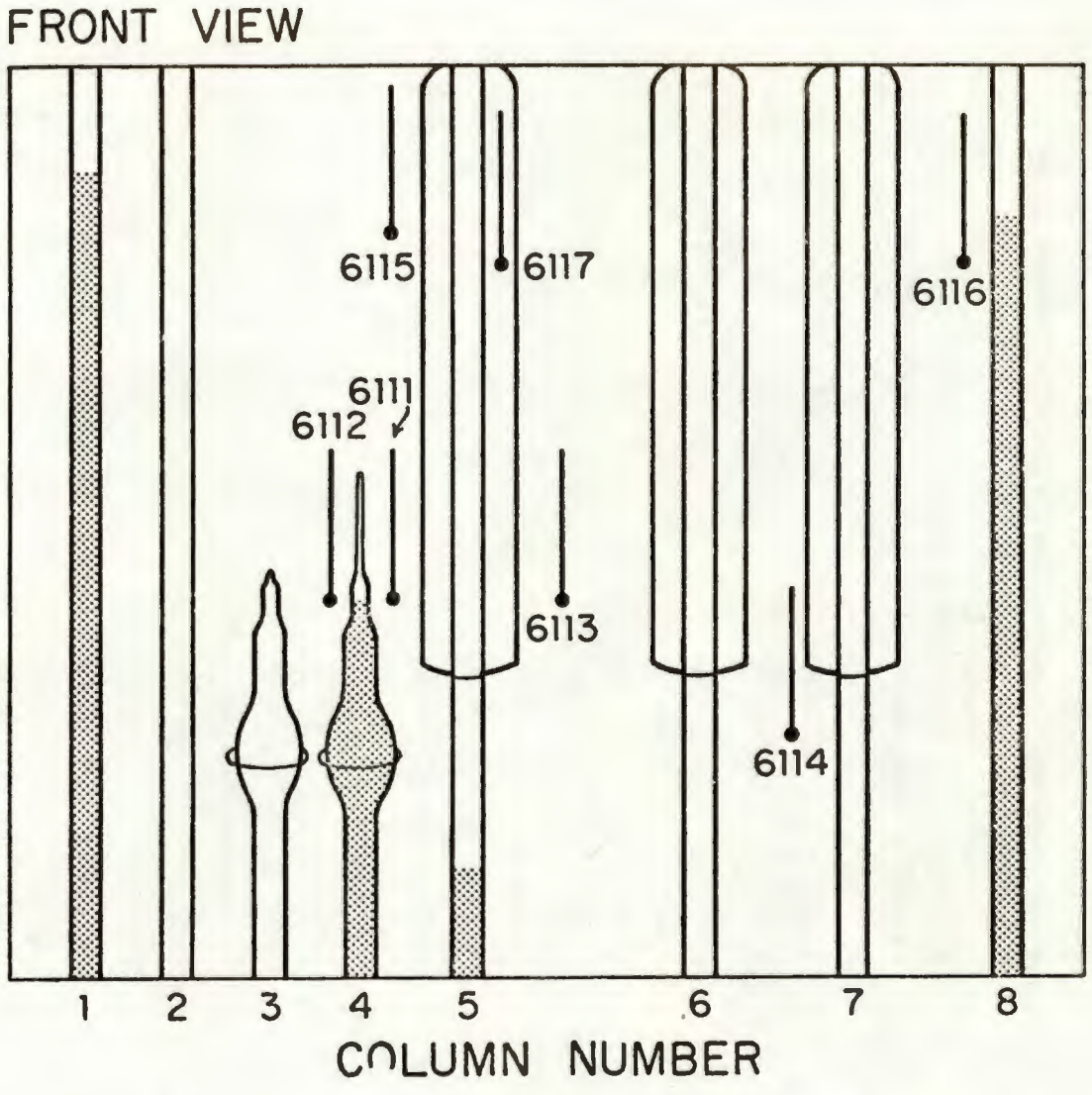
Run No.	Date	Corrected** Deviations of Thermometers from No. 6111 in °C							Comments
		6114	6113	6111	6112	6115	6117	6116	
21	11 May 70	.00	-.05	19.82	-.02	-.03	-.05	.00	
22	12 May 70	.00	-.03	19.68	-.01	-.02	-.05	+.01	
23	12 May 70	-.01	-.04	19.96	-.01	-.03	-.05	.00	
24	13 May 70	.00	-.03	19.68	-.01	-.01	-.05	+.01	
25	14 May 70	.00	-.03	19.70	-.02	-.03	-.03	+.01	
26	14 May 70	-.02	-.04	20.14	-.01	-.03	-.04	.00	
27	15 May 70	-.01	-.04	19.90	-.02	-.03	-.05	.00	
	Averages	.00	-.03		-.01	-.02	-.04	+.01	
	Overall Averages	-.01	-.04		-.01	-.02	-.04	.00	

* Except as otherwise noted, readings were made after all cabinet fans had been on for at least one hour.

** Corrections added to observed temperatures (determined by Elliot Atlas in September 1968 - Book II, Part 3, Page 29):

6112	+.01°C
6113	+.02
6114	-.03
6115	+.03
6116	-.03
6117	-.03

Figure 2. Placement of Thermometers in Manometric System Cabinet



Front to Rear Placement:

6111, 6112: Close to front beside Col. No. 4 at 4cc pointer

6114, 6117: About halfway to rear

6113, 6115: Close to rear beside Col. No. 5

6116: Between 6113 and 6114 beside large manometer control ballast (not pictured)

Table 5. I.R. Analyzer Runs on Manometer Calibration Reference Gases

Cylinder No.	Date	REFGAS Report No.	Standard Cylinder No.	Pressure of Compared cylinder (p.s.i.)	No. of Comparisons	Index Value (ppm)
6078	17 Jul 69	16	4284	2140	12	311.54
	25 Jul 69	16	4284	2110	10	311.49
	14 Aug 69	16	4284	2120	10	311.53
	28 Oct 69	16	4284	2110	10	311.61
	6 Nov 69	16	4284	2110	11	311.36
	18 Nov 69	16	4284	2100	12	311.49
	5 Dec 69	16	4284	1830	10	311.56
	22 Jan 70	16	4284	1680	10	311.51
	2 Mar 70	17*	18220	1690	10	311.51
	12 Mar 70	17*	4284	1680	9	311.46
	17 Apr 70	17*	4293	1680	9	311.62
	18 May 70	17*	4284	1560	10	311.32
			Weighted Average		123	311.50*
2399	12 Sep 68	15	11076	2120	11	322.42
	6 Nov 69	16	4284	2120	10	322.28
	18 Nov 69	16	4284	2110	12	322.34
	5 Dec 69	16	4284	2000	10	322.29
	22 Jan 70	16	4284	1970	10	322.30
	24 Feb 70	17*	4284	1970	10	322.27
	16 Mar 70	17*	4284	1900	10	322.23
	17 Apr 70	17*	4284	1850	10	322.28
	18 May 70	17*	4284	1750	10	322.27
			Weighted Average		93	322.30*

Table 5. I.R. Analyzer Runs on Manometer Calibration Reference Gases (con't)

Cylinder No.	Date	REFGAS Report No.	Standard Cylinder No.	Pressure of Compared cylinder (p.s.i.)	No. of Comparisons	Index Value (ppm)
10069	13 Jun 69	15	11076	2120	11	346.85
	2 Jul 69	16	18220	2100	14	346.80
	14 Aug 69	16	4284	2100	10	346.75
	28 Oct 69	16	18220	2100	10	346.89
	19 Dec 69	16	4284	2040	10	346.83
	22 Jan 70	16	4284	2010	9	346.84
	24 Feb 70	17*	4284	2000	10	346.78
	16 Mar 70	17*	18220	2000	11	346.66
	17 Apr 70	17*	4284	2000	10	346.70
	18 May 70	17*	4284	1930	10	346.83
			Weighted Average		105	346.80*
7366	2 Jul 68	14	18207	2100	10	282.47†
	1 Oct 68	15	11076	2170	9	282.59†
	15 Apr 69	15	6067	2120	10	281.68°
	5 Feb 70	17	4284	2050	11	282.22†
	5 Feb 70	17*	4284	2050	11	281.45°
	18 May 70	17*	4284	1930	10	282.12†
			Weighted Average		40	282.35†*
			Weighted Average		21	281.57°*

* REFGAS temporary value

† Determined with High Span RSF

° Determined with Low Span RSF (I_{LS} = 2400)

Table 6. Summary and Comparison of Calibration Results

Cylinder No.	Infrared: Index Value (ppm)	Infrared: Calculated: 1959 Mano. Value* (ppm)	Infrared: Calculated: 1968 Gravimetric Value** (ppm)	Manometric: Phase I Individual Partial Pressure (1st Runs only) (ppm)	Manometric: Average Partial Pressure (ppm)	Manometric: Standard Deviation (ppm)	Differences: Partial Pressure–Index (ppm)	Differences: Partial Pressure–Gravimetric (ppm)
6078	311.50	311.50	308.99	312.05				
				312.22				
				311.82				
				312.18				
				312.15				
				312.27				
				312.33				
				Av. of 7	312.15	.16	.65	3.16
2399	322.30	324.66	322.34	325.31				
				(325.80)				
				325.23				
				(325.70)				
				325.33				
				325.31				
				325.45				
				325.23				
				Av. of 8	325.42	.20	3.12	3.08
				Av. of 6 (Values in brackets omitted)	325.31	.07	3.01	2.97
10069	346.80	354.51	353.78	356.91				
				357.04				
				356.74				
				356.95				
				Av. of 4	356.91	.11	10.11	3.13

Table 6. Summary and Comparison of Calibration Results (con't)

Cylinder No.	Infrared Index Value (ppm)	Infrared Calculated 1959 Mano. Value* (ppm)	Infrared Calculated 1968 Gravimetric Value** (ppm)	Manometric Phase I Individual Partial Pressure (1st Runs only) (ppm)	Manometric Average Partial Pressure (ppm)	Manometric Standard Deviation (ppm)	Differences Partial Pressure-Index (ppm)	Differences Partial Pressure-Gravimetric (ppm)
7366	282.35***	275.95	274.52	277.62				
				277.72				
				277.74				
				Av. of 3	277.69	.05	-4.66	3.17
	281.57****	275.04	273.63				-3.88	4.06

* 1959 Mano. equation

$$\mu_{mano.} = (\mu_{index} - 311.51) \cdot 1.2186 + 311.51$$

** 1968 Gravimetric equation by C. S. Wong

$$\mu_{wt} = 58.4220 + 0.387232\ \mu_{index} + 0.00133919\ (\mu_{index})^2$$

*** Index value derived from runs made with High Span RSF determination

**** Index value derived from runs made with Low Span RSF determination

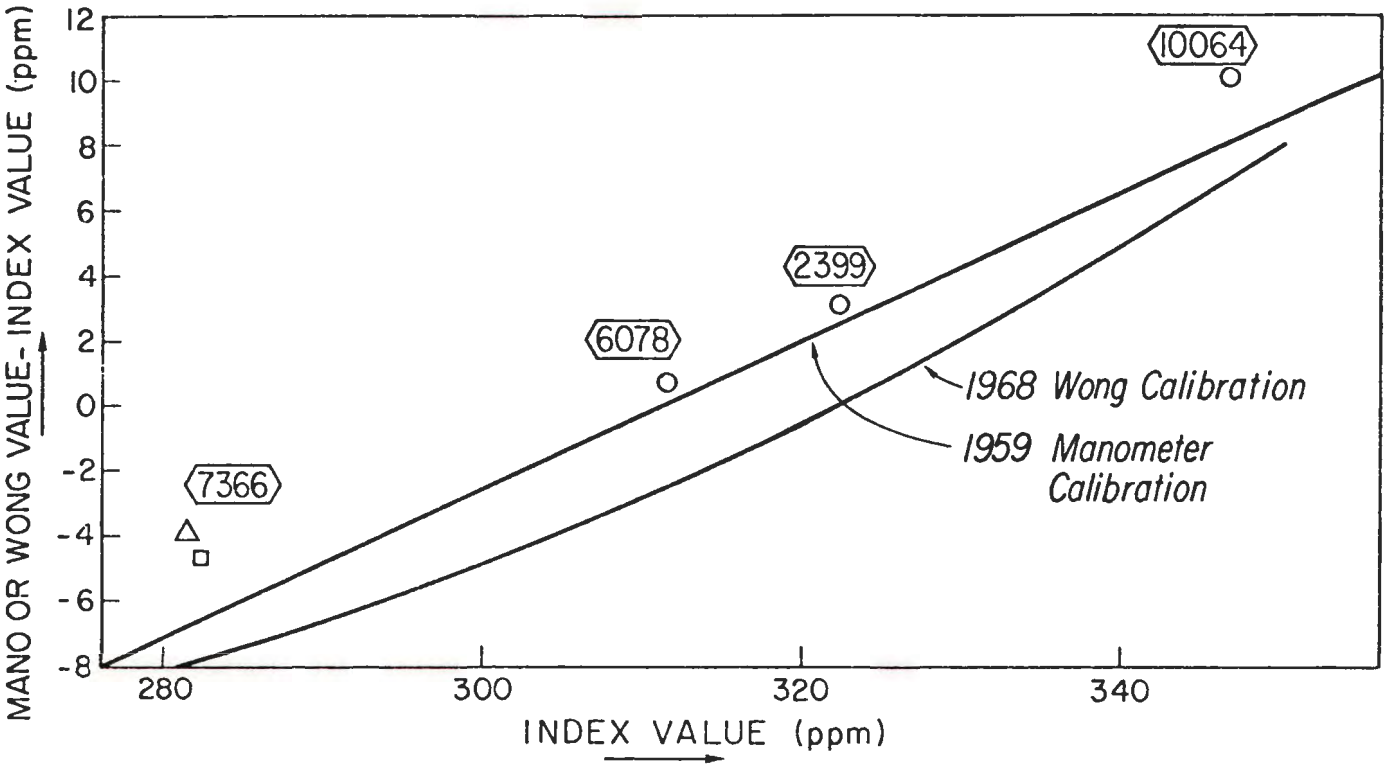


Figure 3. Calibration Comparison. The circles, squares and triangles represent the results of the 1969-70 manometric calibration. The triangle uses an index value derived from a low span calibration of the analyzer for gas 7366, while the square uses an index value derived derived from a high span calibration.

Appendix 1. (Table 1.) Manometric Reference Gas Calibrations - Experimental Data

This table summarizes the experimental data of the 1969-70 manometric calibration in the same format used in Manometer Reports II and III. In all runs the second 4 cc measurement listed was made after transferring the sample out of and then back into the small manometer (see text).

TABLE 1. MANOMETRIC REFFRENCE GAS CALIBRATIONS - EXPERIMENTAL DATA

CYLINDER NO. -RUN NO.	REF. GAS TYPE	DATE	VOLUME CC	VAC.COL. HEIGHT,MM	SAMPLE COL. HEIGHT,MM	TEMP. DEG.C	MENIS. CORR.,MM
6078 - 6	CO2 IN N2	1 DEC 69	5000	772.173	177.232	20.15	-0.070
		2 DEC 69	4	618.844	374.697	20.01	-0.430
		2 DEC 69	4	618.899	374.646	20.09	-0.430
6078 - 7	CO2 IN N2	2 DEC 69	5000	769.870	177.252	19.91	-0.070
		2 DEC 69	4	618.124	374.682	19.91	-0.430
		3 DEC 69	4	618.472	374.684	20.24	-0.430
2399 - 1	CO2 IN N2	3 DEC 69	5000	766.602	177.249	20.29	-0.070
		3 DEC 69	4	626.890	374.694	20.21	-0.430
		4 DEC 69	4	626.996	374.678	20.58	-0.430
2399 - 2	CO2 IN N2	4 DEC 69	5000	777.489	177.274	20.40	-0.070
		4 DEC 69	4	631.857	374.685	20.30	-0.430
		5 DEC 69	4	631.688	374.693	20.23	-0.430
6078 - 8	CO2 IN N2	8 DEC 69	5000	768.700	177.370	19.89	-0.070
		9 DEC 69	4	617.370	374.774	19.88	-0.430
		9 DEC 69	4	617.566	374.779	20.18	-0.430
6078 - 9	CO2 IN N2	9 DEC 69	5000	767.572	177.315	19.68	-0.070
		10 DEC 69	4	616.716	374.621	19.26	-0.430
		10 DEC 69	4	617.249	374.620	19.99	-0.430
10069 - 1	CO2 IN N2	10 DEC 69	5000	771.326	177.243	19.95	-0.070
		11 DEC 69	4	652.387	374.613	18.75	-0.430
		11 DEC 69	4	653.019	374.594	19.53	-0.430

TABLE 1. MANOMETRIC REFERENCE GAS CALIBRATIONS - EXPERIMENTAL DATA

CYLINDER NO. -RUN NO.	REF. GAS TYPE	DATE	VOLUME CC	VAC. COL. HEIGHT, MM	SAMPLE COL. HEIGHT, MM	TEMP. DEG. C	MENIS. CORR., MM
6075 -10	CO2 IN N2	11 DEC 69	5000	774.840	177.182	19.39	-0.070
		11 DEC 69	4	620.472	374.621	19.86	-0.430
		12 DEC 69	4	620.165	374.629	19.62	-0.430
6075 -11	CO2 IN N2	9 MAR 70	5000	764.348	173.649	19.30	-0.127
		10 MAR 70	4	613.548	371.014	19.19	-0.384
		10 MAR 70	4	613.381	370.996	19.13	-0.384
2399 - 3	CO2 IN N2	10 MAR 70	5000	760.504	173.657	19.14	-0.127
		11 MAR 70	4	622.094	371.019	19.19	-0.384
		12 MAR 70	4	622.165	370.994	19.26	-0.384
2399 - 4	CO2 IN N2	12 MAR 70	5000	764.160	173.552	19.25	-0.127
		12 MAR 70	4	624.113	371.014	19.36	-0.384
		12 MAR 70	4	624.028	371.001	19.32	-0.384
2399 - 5	CO2 IN N2	23 APR 70	5000	773.375	173.374	20.04	-0.104
		23 APR 70	4	627.755	370.962	20.16	-0.330
		24 APR 70	4	627.410	370.948	19.88	-0.330
10069 - 2	CO2 IN N2	24 APR 70	5000	766.329	173.512	19.88	-0.104
		24 APR 70	4	649.408	370.963	20.03	-0.330
		24 APR 70	4	649.137	370.943	19.86	-0.330
10069 - 3	CO2 IN N2	27 APR 70	5000	771.880	173.519	19.54	-0.104
		28 APR 70	4	651.634	370.944	19.56	-0.330
		28 APR 70	4	651.895	370.964	19.71	-0.330

TABLE 1. MANOMETRIC REFERENCE GAS CALIBRATIONS - EXPERIMENTAL DATA

CYLINDER NO. -RUN NO.	REF. GAS TYPE	DATE	VOLUME CC	VAC.COL. HEIGHT,MM	SAMPLE COL. HEIGHT,MM	TEMP. DEG.C	MENIS. CORR.,MM
2399 - 6	CO2 IN N2	28 APR 70	5000	762.994	173.472	19.60	-0.104
		29 APR 70	4	622.990	370.970	19.40	-0.330
		29 APR 70	4	623.235	370.973	19.68	-0.330
7366 - 1	CO2 IN N2	11 MAY 70	5000	759.159	173.600	19.80	0.000
		11 MAY 70	4	585.092	370.982	19.98	-0.444
		12 MAY 70	4	584.772	371.005	19.67	-0.444
7366 - 2	CO2 IN N2	12 MAY 70	5000	765.191	173.633	19.66	0.000
		12 MAY 70	4	587.199	370.962	19.65	-0.444
		12 MAY 70	4	587.418	370.971	19.91	-0.444
7366 - 3	CO2 IN N2	12 MAY 70	5000	768.269	173.495	19.94	0.000
		13 MAY 70	4	588.257	370.974	19.74	-0.444
		13 MAY 70	4	588.190	370.949	19.75	-0.444
2399 - 7	CO2 IN N2	13 MAY 70	5000	764.334	173.561	19.66	0.000
		13 MAY 70	4	624.333	370.965	20.09	-0.444
		14 MAY 70	4	623.965	370.947	19.68	-0.444
10069 - 4	CO2 IN N2	14 MAY 70	5000	760.347	173.545	19.67	0.000
		14 MAY 70	4	646.598	370.962	19.73	-0.444
		14 MAY 70	4	646.910	370.969	20.05	-0.444
6078 -12	CO2 IN N2	14 MAY 70	5000	762.000	173.492	20.09	0.000
		15 MAY 70	4	612.586	370.998	19.73	-0.444
		15 MAY 70	4	612.607	370.976	19.81	-0.444

TABLE 1. MANOMETRIC REFERENCE GAS CALIBRATIONS - EXPERIMENTAL DATA

CYLINDER NO. -RUN NO.	REF. GAS TYPE	DATE	VOLUME CC	VAC. COL. HEIGHT, MM	SAMPLE COL. HEIGHT, MM	TEMP. DEG. C	MENIS. CORR., MM
2399 - 8	CO2 IN N2	15 MAY 70	5000	762.927	173.588	19.85	0.000
		15 MAY 70	4	623.445	370.956	20.17	-0.444
		15 MAY 70	4	623.625	370.949	20.44	-0.444

Appendix 2. Pointer Heights for Reference Gas Calibrations

Cylinder No. - Run No.	Date	Volume, cc.	Pointer Height, mm
6078-6	1 DEC 69	5000	177.448
	2 DEC 69	4	374.660
	2 DEC 69	4	374.645
6078-7	2 DEC 69	5000	177.468
	2 DEC 69	4	374.644
	3 DEC 69	4	374.684
2399-1	3 DEC 69	5000	177.454
	3 DEC 69	4	374.690
	4 DEC 69	4	374.675
2399-2	4 DEC 69	5000	177.500
	4 DEC 69	4	374.680
	5 DEC 69	4	374.680
6078-8	8 DEC 69	5000	177.592
	9 DEC 69	4	374.782
	9 DEC 69	4	374.800
6078-9	9 DEC 69	5000	177.590
	10 DEC 69	4	374.614
	10 DEC 69	4	374.618
10069-1	10 DEC 69	5000	177.408
	11 DEC 69	4	374.620
	11 DEC 69	4	374.600
6078-10	11 DEC 69	5000	177.420
	11 DEC 69	4	374.618
	12 DEC 69	4	374.632
6078-11	9 MAR 70	5000	173.802
	10 MAR 70	4	371.020
	10 MAR 70	4	370.996
2399-3	10 MAR 70	5000	173.800
	11 MAR 70	4	371.014
	12 MAR 70	4	370.984
2399-4	12 MAR 70	5000	173.820
	12 MAR 70	4	370.990
	12 MAR 70	4	371.018
2399-5	23 APR 70	5000	173.756
	23 APR 70	4	370.948
	24 APR 70	4	370.970
10069-2	24 APR 70	5000	173.790
	24 APR 70	4	370.956
	24 APR 70	4	370.972
10069-3	27 APR 70	5000	173.752
	28 APR 70	4	370.972
	28 APR 70	4	370.950

Appendix 2. Pointer Heights for Reference Gas Calibrations (con't)

Cylinder No. - Run No.	Date	Volume, cc.	Pointer Height, mm
2399-6	28 APR 70	5000	173.758
	29 APR 70	4	370.972
	29 APR 70	4	370.960
7366-1	11 MAY 70	5000	173.776
	11 MAY 70	4	370.980
	12 MAY 70	4	371.000
7366-2	12 MAY 70	5000	173.760
	12 MAY 70	4	370.980
	12 MAY 70	4	370.960
7366-3	12 MAY 70	5000	173.738
	13 MAY 70	4	370.996
	13 MAY 70	4	370.963
2399-7	13 MAY 70	5000	173.766
	13 MAY 70	4	370.970
	14 MAY 70	4	370.970
10069-4	14 MAY 70	5000	173.746
	14 MAY 70	4	370.950
	14 MAY 70	4	370.976
6078-12	14 MAY 70	5000	173.748
	15 MAY 70	4	370.990
	15 MAY 70	4	370.978
2399-8	15 MAY 70	5000	173.726
	15 MAY 70	4	370.940
	15 MAY 70	4	370.958

Appendix 3. Infrared Analyzer Measurements on Manometric Reference Gases

The following pages summarize the index values determined on the infrared analyzer AP55 in Room 2317 Ritter Hall, S.I.O. for the reference gases analyzed on the constant volume manometric system in 1969-70. The pages are copies made from Table 9 of Reference Gas Report 17. Under the heading, "Single Set", are listed the index values obtained on given dates of analyses. The Cumulative Average is taken over all the analyses made on a reference gas, while the Subcumulative Average if different from the cumulative is taken over only a recent part of the analyses. Column 1 lists the standard reference gases to which the manometric reference gases were directly compared on the analyzer. Column 9 lists the cylinder pressure in pounds per square inch. Columns 11 to 14 list codes used in the reference gas system and will not be described here.

For gas 7366, the two analyses derived from low span calibrations, the runs made on 4/15/69 and 2/5/70, are starred and are omitted from the Cumulative Average. The average thus is made only over analyses derived from high span calibrations (see text).

TABLE 9. SUMMARY OF THE HISTORY OF ALL TANKS THROUGH REPORT 17

1	2	3	4	5	6	7	8	9	10	11 12 13 14
		SINGLE SET		CUMULATIVE AV.		SUBCUM. AV.		COMPARED		CODES
STANDARD TANK NO.	COMPARED TANK NO.	NO. OF COMPARISONS	INDEX	NO. OF COMPARISONS	INDEX	NO. OF COMPARISONS	INDEX	TANK PRESSURE	DATE OF ANALYSIS	USE-RUN-RPT-CARD NO NO
	2399			0	0	0	0		7/ 3/68	7777-135-14- 660
	2399			0	0	0	0		8/26/68	601-115-14-1400
11076	2399	11	322.42	11	322.42	11	322.42	2120	9/12/68	600-110-15- 690
	2399			11	322.42	11	322.42		11/ 5/69	5101-115-16-2070
4284	2399	10	322.28	21	322.35	21	322.35	2120	11/ 6/69	5101-110-16-2220
	2399			21	322.35	21	322.35		11/10/69	5103-115-16-2280
4284	2399	12	322.34	33	322.35	33	322.35	2110	11/18/69	5103-110-16-2360
	2399			33	322.35	33	322.35		11/27/69	210-115-16-2500
4284	2399	10	322.29	43	322.33	43	322.33	2000	12/ 5/69	210-110-16-2640
4284	2399	10	322.30	53	322.33	53	322.33	1970	1/22/70	210-110-16-4230
4284	2399	10	322.25	63	322.32	63	322.32	1970	2/24/70	210-110-17- 620
4284	2399	10	322.23	73	322.30	73	322.30	1900	3/16/70	210-110-17-1130
4284	2399	10	322.27	83	322.30	83	322.30	1850	4/17/70	210-110-17-1980
4284	2399	10	322.25	93	322.29	93	322.29	1750	5/18/70	210-110-17-2280
4284	2399	10	322.29	103	322.29	103	322.29	1730	7/14/70	210-110-17-3140
181	2399	10	322.20	113	322.29	113	322.29	1760	8/17/70	210-110-17-3780
181	2399	10	322.21	123	322.28	123	322.28	1730	9/25/70	210-110-17-4540
181	2399	11	322.08	134	322.26	134	322.26	1720	12/14/70	210-110-17-5550
	2400			0	0	0	0		8/23/66	7777-135-10-2760
	2400			0	0	0	0		9/ 8/66	1-115-10-2900
11089	2400	10	281.32	10	281.32	10	281.32	2150	9/21/66	31-110-10-3290
2408	2400	10	280.81	20	281.06	20	281.06	2150	9/21/66	31-110-10-3320
11089	2400	10	281.23	30	281.12	30	281.12	2140	9/28/66	31-110-10-3390
2408	2400	10	280.83	40	281.05	40	281.05	2130	9/28/66	31-110-10-3420
11089	2400	10	281.28	50	281.09	50	281.09	2100	10/25/66	31-110-10-4010
2408	2400	10	280.80	60	281.04	60	281.04	2100	10/25/66	31-110-10-4040

TABLE 9, SUMMARY OF THE HISTORY OF ALL TANKS THROUGH REPORT 17

1	2	3	4	5	6	7	8	9	10	11 12 13 14
		SINGLE SET		CUMULATIVE AV.		SUBCUM, AV,		COMPARED		CODES
STANDARD TANK NO.	COMPARED TANK NO.	NO. OF COMPARI-SONS	INDEX	NO. OF COMPARI-SONS	INDEX	NO. OF COMPARI-SONS	INDEX	TANK PRESSURE	DATE OF ANALYSIS	USE-RUN-RPT-CARD NO NO
18207	6074	10	293,87	166	294.31	20	293,91	940	3/25/68	5135- 10-13-2900
18207	6074	11	293,92	177	294.29	31	293,91	890	3/28/68	5135- 10-13-3120
18207	6074	11	293,85	188	294.26	42	293,90	900	4/ 9/68	5135- 10-13-3410
11194	6074	9	293,88	197	294.25	51	293,89	880	4/ 9/68	5135- 10-13-3450
	6074			197	294.25	51	293,89		4/11/68	431- 15-14- 70
11176	6074	10	294,33	207	294.25	61	293,97	890	9/23/68	431- 10-15-1230
2400	6074	11	293,65*	207	294,25	61	293,97	880	4/15/69	431- 17-15-3550
	6074			207	294.25	61	293,97		4/21/69	430- 15-15-3670
	6074			207	294.25	61	293,97		5/20/69	630- 15-15-4510
	6074			207	294.25	61	293,97		11/ 5/69	5153- 15-16-2120
4284	6074	11	294,23	218	294.25	72	294,01	870	11/ 6/69	5153- 10-16-2250
	6074			218	294.25	72	294,01		12/ 3/69	5154- 15-16-2520
	6078			0	0	0	0		5/23/69	7777-135-15-4580
	6078			0	0	0	0		7/16/69	1-115-16- 270
4284	6078	12	311,54	12	311.54	12	311,54	2140	7/17/69	1-110-16- 380
4284	6078	10	311,49	22	311,52	22	311,52	2110	7/25/69	1-110-16- 540
	6078			22	311.52	22	311,52		7/29/69	410-115-16- 620
4284	6078	10	311,53	32	311,52	32	311,52	2120	8/14/69	410-110-16- 840
4284	6078	10	311,61	42	311.54	42	311.54	2110	10/28/69	410-110-16-1880
	6078			42	311,54	42	311,54		11/ 5/69	5313-115-16-2130
4284	6078	11	311,35	53	311.50	53	311,50	2110	11/ 6/69	5313-110-16-2240
4284	6078	12	311,49	65	311.50	65	311,50	2100	11/18/69	5313-110-16-2370
	6078			65	311.50	65	311,50		11/26/69	210-115-16-2490
4284	6078	10	311,56	75	311,51	75	311,51	1830	12/ 5/69	210-110-16-2600
4284	6078	10	311,51	85	311,51	85	311,51	1680	1/22/70	210-110-16-4210
18220	6078	10	311,51	95	311.51	95	311,51	1690	3/ 2/70	210-110-17- 830
4284	6078	9	311,45	104	311.50	104	311,50	1680	3/17/70	210-110-17-1280

TABLE 9. SUMMARY OF THE HISTORY OF ALL TANKS THROUGH REPORT 17

1	2	3	4	5	6	7	8	9	10	11 12 13 14
		SINGLE SET		CUMULATIVE AV.		SURCUM. AV.		COMPARED		CODES
STANDARD TANK NO.	COMPARED TANK NO.	NO. OF COMPARI-SONS	INDEX	NO. OF COMPARI-SONS	INDEX	NO. OF COMPARI-SONS	INDEX	TANK PRESSURE	DATE OF ANALYSIS	USE-RUN-RPT-CARD NO NO
4293	6078	9	311,62	113	311.51	113	311,51	1680	4/17/70	210-110-17-2040
4284	6078	10	311,31	123	311.50	123	311,50	1560	5/18/70	210-110-17-2270
4284	6078	10	311,44	133	311.49	133	311,49	1670	7/14/70	210-110-17-3160
181	6078	10	311,52	143	311.49	143	311,49	1680	8/17/70	210-110-17-3760
181	6078	10	311,42	153	311.49	153	311,49	1660	9/25/70	210-110-17-4560
181	6078	10	311,6?	163	311.50	163	311,50	1640	12/14/70	210-110-17-5540
	6081			0	0	0	0		11/ 4/69	7777-235-16-1990
	6081			0	0	0	0		12/18/69	1-215-16-2770
4284	6081	11	321,96	11	321.96	11	321,96	2140	12/18/69	1-210-16-2900
	6081			11	321.96	11	321,96		12/22/69	5103-215-16-3140
4284	6081	10	321,91	21	321.94	21	321,94	2120	12/23/69	5103-210-16-3320
	6081			21	321.94	21	321,94		1/30/70	5104-215-16-4460
	6081			21	321.94	0	0		10/27/70	5105-225-17-4780
181	6081	10	321,86	31	321.91	10	321,86	480	12/ 4/70	5105-210-17-5190
	6081			31	321.91	10	321,86		12/ 9/70	7770-215-17-5350
	6775			0	0	0	0		12/28/70	10423- 15-17-5830
	6985			0	0	0	0		4/ 1/68	7777-135-13-3280
	6985			0	0	0	0		6/ 3/68	5203-115-14- 190
18207	6985	11	318,46	11	318,46	11	318,46	2210	7/18/68	5203-110-14- 810
	6985			11	318,46	11	318,46		7/30/68	5204-115-14- 960

TABLE 9, SUMMARY OF THE HISTORY OF ALL TANKS THROUGH REPORT 17

1	2	3	4	5	6	7	8	9	10	11 12 13 14
		SINGLE	SET	CUMULATIVE	AV,	SUBCUM,	AV,	COMPARED		CODES
STANDARD TANK NO,	COMPARED TANK NO,	NO, OF COMPARI- SONS	INDEX	NO, OF COMPARI- SONS	INDEX	NO, OF COMPARI- SONS	INDEX	TANK PRESSURE	DATE OF ANALYSIS	USE*RUN-RPT-CARD NO NO
	7362			10	323.35	10	323,35		1/12/70	7770-215-16-3790
	7362			0	0	0	0		12/11/70	7777-335-17-5420
	7364			0	0	0	0		4/ 1/68	7777-335-13-3250
	7364			0	0	0	0		4/30/68	431-315-14- 140
18207	7364	10	285,31	10	285.31	10	285,31	2100	7/ 2/68	431-310-14- 480
11076	7364	10	285.47	20	285.39	20	285,39	2120	10/ 1/68	430-310-15-1570
2400	7364	12	284,40*	20	285.39	20	285,39	2080	4/15/69	430-317-15-3510
4284	7364	10	285,05	30	285.28	30	285,28	2060	7/14/70	430-310-17-3180
4284	7364	9	284,89	39	285.19	39	285,19	2040	7/23/70	430-310-17-3340
181	7364	10	285,10	49	285.17	49	285,17	2040	9/22/70	430-310-17-4400
181	7364	10	285,18	59	285.17	59	285,17	2000	12/ 8/70	430-310-17-5310
	7366			0	0	0	0		4/ 1/68	7777-335-13-3260
	7366			0	0	0	0		4/30/68	431-315-14- 150
18207	7366	10	282.47	10	282.47	10	282,47	2100	7/ 2/68	431-310-14- 460
11076	7366	9	282.59	19	282.53	19	282,53	2170	10/ 1/68	430-310-15-1590
6067	7366	10	281,68*	19	282.53	19	282,53	2120	4/15/69	430-317-15-3480
	7366			19	282.53	19	282,53		12/12/69	230-315-16-2570
4284	7366	11	282,20	30	282.41	30	282,41	2050	2/ 5/70	230-310-17- 190
2400	7366	10	281,48*	30	282.41	30	282,41	2030	2/ 5/70	230-317-17- 200
4284	7366	10	282,14	40	282.34	40	282,34	1930	5/18/70	230-310-17-2260
4284	7366	10	282,24	50	282.32	50	282,32	1930	7/14/70	230-310-17-3200
4284	7366	10	282,18	60	282.30	60	282,30	1920	7/23/70	230-310-17-3360
181	7366	10	282,35	70	282.31	70	282,31	1930	7/31/70	230-310-17-3530

TABLE 9. SUMMARY OF THE HISTORY OF ALL TANKS THROUGH REPORT 17

1	2	3	4	5	6	7	8	9	10	11 12 13 14
		SINGLE SET		CUMULATIVE AV.		SUBCUM. AV.		COMPARED		CODES
STANDARD TANK NO.	COMPARED TANK NO.	NO. OF COMPARI-SONS	INDEX	NO. OF COMPARI-SONS	INDEX	NO. OF COMPARI-SONS	INDEX	TANK PRESSURE	DATE OF ANALYSIS	USE-RUN-RPT-CARD NO NO
181	7366	10	282.40	80	282.32	80	282.32	1910	8/20/70	230-310-17-3910
181	7366	10	282.27	90	282.31	90	282.31	1910	9/22/70	230-310-17-4420
181	7366	10	282.37	100	282.32	100	282.32	1900	12/ 8/70	230-310-17-5280
	9184			0	0	0	0		6/20/64	7777- 35--0- 0
	9184			0	0	0	0		9/ 1/66	7600- 15-10-2860
	9184			0	0	0	0		7/ 9/70	7777-135-17-3070
	9184			0	0	0	0		7/21/70	7600-115-17-3250
	9200			0	0	0	0		6/20/64	7777- 35--0- 0
	9200			0	0	0	0		9/ 1/66	7600- 15-10-2870
	9200			0	0	0	0		7/ 9/70	7777-135-17-3080
	9200			0	0	0	0		7/21/70	7600-115-17-3260
	10063			0	0	0	0		1/12/68	7777-235-13- 680
	10063			0	0	0	0		3/ 5/68	5203-215-13-2230
18207	10063	10	311.97	10	311.97	10	311.97	2190	3/15/68	5203-210-13-2400
	10063			10	311.97	10	311.97		3/18/68	5204-215-13-2470
	10064			0	0	0	0		1/12/68	7777-135-13- 690

TABLE 9, SUMMARY OF THE HISTORY OF ALL TANKS THROUGH REPORT 17

1	2	3	4	5	6	7	8	9	10	11 12 13 14
		SINGLE SET		CUMULATIVE AV.		SUBCUM. AV.		COMPARED		CODES
STANDARD TANK NO.	COMPARED TANK NO.	NO. OF COMPARISONS	INDEX	NO. OF COMPARISONS	INDEX	NO. OF COMPARISONS	INDEX	TANK PRESSURE	DATE OF ANALYSIS	USE-RUN-RPT-CARD NO NO
	10067			0	0	0	0		11/13/68	7777-235-15-2110
	10067			0	0	0	0		12/13/68	611-215-15-2270
6067	10067	10	313,51	10	313.51	10	313,51	2140	1/28/69	610-210-15-2540
6067	10067	10	313,64	20	313.58	20	313,58	2000	6/13/69	610-210-15-4920
	10067			20	313.58	20	313,58		11/ 5/69	5343-215-16-2140
6067	10067	12	313,56	32	313.57	32	313,57	1980	11/ 6/69	5343-210-16-2260
6067	10067	11	313,63	43	313.58	43	313,58	1950	11/18/69	5343-211-16-2310
18220	10067	11	313,68	54	313.60	54	313,60	1930	11/18/69	5343-212-16-2320
6067	10067	9	313,59	63	313.60	63	313,60	1900	12/ 5/69	5343-210-16-2650
6067	10067	11	313,52	74	313.59	74	313,59	1890	12/24/69	5343-210-16-3380
	10067			74	313.59	74	313,59		12/29/69	5344-215-16-3500
	10068			0	0	0	0		11/13/68	7777-235-15-2120
	10068			0	0	0	0		12/13/68	611-215-15-2280
6067	10068	10	312,36	10	312.36	10	312,36	2140	1/28/69	610-210-15-2550
11076	10068		314,09*	10	312.36	10	312,36	290	6/10/69	610-217-15-4800
11076	10068	10	312,73	20	312.54	20	312,54	290	6/13/69	610-210-15-4840
	10068			20	312.54	20	312,54		6/18/69	7770-215-15-4970
	10068			0	0	0	0		12/11/70	7777-335-17-5430
	10069			0	0	0	0		5/ 5/69	7777-235-15-4300
	10069			0	0	0	0		6/ 9/69	1-215-15-4760
11076	10069	11	346,85	11	346.85	11	346,85	2120	6/13/69	1-210-15-4910
18220	10069	14	346,80	25	346,82	25	346,82	2100	7/ 2/69	1-210-16- 90

TABLE 9, SUMMARY OF THE HISTORY OF ALL TANKS THROUGH REPORT 17

1	2	3	4	5	6	7	8	9	10	11 12 13 14
		SINGLE SET		CUMULATIVE AV.		SUBCUM, AV,		COMPARED		CODES
STANDARD TANK NO,	COMPARED TANK NO,	NO, OF COMPARI- SONS	INDEX	NO, OF COMPARI- SONS	INDEX	NO, OF COMPARI- SONS	INDEX	TANK PRESSURE	DATE OF ANALYSIS	USE-RUN-RPT-CARD NO NO
	10069			25	346.82	25	346,82		7/ 7/69	420-215-16- 180
4284	10069	10	346,75	35	346.80	35	346,80	2100	8/14/69	420-210-16- 890
18220	10069	10	346,89	45	346,82	45	346,82	2100	10/28/69	420-210-16-1830
	10069			45	346.82	45	346,82		12/12/69	220-215-16-2680
4284	10069	10	346,83	55	346,82	55	346,82	2040	12/19/69	220-210-16-2990
4284	10069	9	346,84	64	346,83	64	346,83	2010	1/22/70	220-210-16-4270
4284	10069	10	346,7.	74	346,82	74	346,82	2000	2/24/70	220-210-17- 660
18220	10069	11	346,67	85	346,80	85	346,80	2000	3/16/70	220-210-17-1090
4284	10069	10	346,69	95	346,79	95	346,79	2000	4/17/70	220-210-17-2020
4284	10069	10	346,78	105	346,79	105	346,79	1930	5/18/70	220-210-17-2310
4284	10069	9	346,69	114	346,78	114	346,78	1900	7/14/70	220-210-17-3130
181	10069	10	346,54	124	346,76	124	346,76	2000	9/25/70	220-210-17-4510
18220	10069	10	346,70	134	346,76	134	346,76	1900	12/17/70	220-210-17-5690
	10070			0	0	0	0		4/ 1/68	7777-135-13-3310
	10070			0	0	0	0		6/ 3/68	5203-115-14- 200
18207	10070	12	315,21	12	315,21	12	315,21	2090	7/ 3/68	5203-110-14- 550
	10070			12	315.21	12	315,21		7/30/68	5204-115-14- 970
	10071			0	0	0	0		6/ 9/64	1- 15- 8- 50
2427	10071	10	339,00	10	339,00	10	339,00	2300	7/ 1/64	5223- 10- 8- 120
2427	10071	10	338,95	20	338,98	20	338,98	2300	7/ 2/64	5223- 10- 8- 240
4288	10071	10	338,92	30	338,96	30	338,96	2300	7/24/64	5223- 10- 8- 400
4288	10071	10	339,25	40	339,03	40	339,03	2270	8/26/64	5223- 10- 8- 530
4288	10071	10	338,91	50	339,01	50	339,01	2260	9/17/64	5223- 10- 8- 740
4288	10071	10	338,95	60	339,00	60	339,00	2240	10/26/64	5223- 10- 8-1090
	10071			60	339.00	60	339 00		2/12/65	5224- 15- 9- 130

Appendix 4. Printout from Computer Program MANO 1

The following pages are copies of the printout from computer program MANO 1, which calculates the manometric CO_2 concentrations from the experimental data. See Manometer Report III and its Appendix for a discussion of the method of calculation and a listing of the computer program. Some comments on the printout follow.

In all cases a given run consists of one total gas measurement in the large manometer and two CO_2 measurements in the small manometer, the second being a rerun after transfer of the sample out of and back into the small manometer. Thus for every run there are two pages of printout showing calculation of the CO_2 concentrations by combination of the large manometer measurement with each of the small manometer measurements plus another page summarizing both concentrations obtained for that run. The following experimental data appear on the printout: The observed mercury height, the observed temperatures and the appropriate meniscus corrections. Also shown are the mercury densities, linearly interpolated from the table included in the program; the virial coefficients, interpolated from the tabular values using a quadratic Lagrangian interpolation; the calculated pressure in dynes per square centimeter; the values of the constants, acceleration due to gravity and gas constant; and the calibrated volumes of the 4 cc and 5000 cc sample chambers.

The runs made in 1969-70 are arranged in the appendix in order

of reference gas cylinder number. Various comments appear on some of the printouts, referring to a particular CO_2 measurement. In the earlier runs a comment is made that the transfers were made using liquid solid ethanol, i.e. that the sublimations were made at the temperature of a liquid-solid ethanol slush, or about -100°C. In all other cases, a dry ice slush, at -78°C, was used. The transfer time length is also specified. For the first CO_2 measurements of runs where no comment is made the time is either five minutes or three minutes (near the end of the calibrations).

NO. OF TESTED CYLINDER = 2399, RUN NO. 1 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.430 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = -0.070 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 626.890 MM AND 374.694 MM--TEMPERATURE WAS 20.21 DEG. C
MERCURY DENSITY WAS 13.5453 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 766.602 MM AND 177.249 MM--TEMPERATURE WAS 20.29 DEG. C
MERCURY DENSITY WAS 13.5451 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	20.21	TEMPERATURE(C)	20.29
PRESSURE(DYNE/SC)	.33405E+06	PRESSURE(DYNE/SC)	.78188E+06
VIRIAL(CC/MOLE)	-127.8	VIRIAL(CC/MOLE)	-6.0

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 324.12 PPM

CO2 MEASUREMENT -- TRANSFERS USING LIQUID-SOLID ETHANOL

THIS MEASUREMENT WAS MADE ON 3 DEC 69

OBTAINED FROM CO2 MEASUREMENT NO. 1 AND TOTAL GAS MEASUREMENT NO. 1

NO. OF TESTED CYLINDER = 2399, RUN NO. 1 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.430 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = -0.070 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 626.996 MM AND 374.678 MM--TEMPERATURE WAS 20.58 DEG. C
MERCURY DENSITY WAS 13.5444 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 766.602 MM AND 177.249 MM--TEMPERATURE WAS 20.29 DEG. C
MERCURY DENSITY WAS 13.5451 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	20.58	TEMPERATURE(C)	20.29
PRESSURE(DYNE/SC)	.33419E+06	PRESSURE(DYNE/SC)	.78188E+06
VIRIAL(CC/MOLE)	-127.4	VIRIAL(CC/MOLE)	-6.0

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 323.84 PPM

CO2 MEASUREMENT -- RERUN AFTER TRANSFER OF SAMPLE OUT OF MANOMETER THEN BACK INTO MANOMETER USING LIQUID-SOLID ETHANOL.

THIS MEASUREMENT WAS MADE ON 3 DEC 69 (TOTAL GAS) AND 4 DEC 69 (CO2)

OBTAINED FROM CO2 MEASUREMENT NO. 2 AND TOTAL GAS MEASUREMENT NO. 1

SUMMARY OF MANOMETRIC CO2 CONCENTRATIONS ON CYLINDER NO. 2399 RUN NO. 1

TOTAL GAS RUN NO.	CO2 RUN NO.	CONC.
1	1	324.12
1	2	323.84

NO. OF TESTED CYLINDER = 2399, RUN NO. 2 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.430 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = -0.070 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 631.857 MM AND 374.685 MM--TEMPERATURE WAS 20.30 DEG. C
MERCURY DENSITY WAS 13.5451 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 777.489 MM AND 177.274 MM--TEMPERATURE WAS 20.40 DEG. C
MERCURY DENSITY WAS 13.5449 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	20.30	TEMPERATURE(C)	20.40
PRESSURE(DYNE/SC)	.34065E+06	PRESSURE(DYNE/SC)	.79627E+06
VIRIAL(CC/MOLE)	-127.7	VIRIAL(CC/MOLE)	-6.0

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 324.57 PPM

CO2 MEASUREMENT -- TRANSFERS USING LIQUID-SOLID ETHANOL

THIS MEASUREMENT WAS MADE ON 4 DEC 69

OBTAINED FROM CO2 MEASUREMENT NO. 1 AND TOTAL GAS MEASUREMENT NO. 1

NO. OF TESTED CYLINDER = 2399, RUN NO. 2 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.430 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = -0.070 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 631.688 MM AND 374.693 MM--TEMPERATURE WAS 20.23 DEG. C
MERCURY DENSITY WAS 13.5453 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 777.489 MM AND 177.274 MM--TEMPERATURE WAS 20.40 DEG. C
MERCURY DENSITY WAS 13.5449 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	20.23	TEMPERATURE(C)	20.40
PRESSURE(DYNE/SC)	.34042E+06	PRESSURE(DYNE/SC)	.79627E+06
VIRIAL(CC/MOLE)	-127.8	VIRIAL(CC/MOLE)	-6.0

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 324.43 PPM

CO2 MEASUREMENT -- RERUN AFTER TRANSFER OF SAMPLE OUT OF MANOMETER THEN BACK INTO MANOMETER USING LIQUID-SOLID ETHANOL.

THIS MEASUREMENT WAS MADE ON 4 DEC 69 (TOTAL GAS) AND 5 DEC 69 (CO2)

OBTAINED FROM CO2 MEASUREMENT NO. 2 AND TOTAL GAS MEASUREMENT NO. 1

SUMMARY OF MANOMETRIC CO2 CONCENTRATIONS ON CYLINDER NO. 2399 RUN NO. 2

TOTAL GAS RUN NO.	CO2 RUN NO.	CONC.
1	1	324.57
1	2	324.43

NO. OF TESTED CYLINDER = 2399, RUN NO. 3 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.384 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = -0.127 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 622.094 MM AND 371.019 MM--TEMPERATURE WAS 19.19 DEG. C
MERCURY DENSITY WAS 13.5479 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 760.504 MM AND 173.657 MM--TEMPERATURE WAS 19.14 DEG. C
MERCURY DENSITY WAS 13.5480 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	19.19	TEMPERATURE(C)	19.14
PRESSURE(DYNE/SC)	.33269E+06	PRESSURE(DYNE/SC)	.77864E+06
VIRIAL(CC/MOLE)	-125.8	VIRIAL(CC/MOLE)	-6.3

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 323.99 PPM

THIS MEASUREMENT WAS MADE ON 10 MAR 70 (TOTAL GAS) AND 11 MAR 70 (CO2)

OBTAINED FROM CO2 MEASUREMENT NO. 1 AND TOTAL GAS MEASUREMENT NO. 1

NO. OF TESTED CYLINDER = 2399 RUN NO. 3 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.384 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = -0.127 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 622.165 MM AND 370.994 MM--TEMPERATURE WAS 19.26 DEG. C
MERCURY DENSITY WAS 13.5477 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 760.504 MM AND 173.657 MM--TEMPERATURE WAS 19.14 DEG. C
MERCURY DENSITY WAS 13.5460 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	19.26	TEMPERATURE(C)	19.14
PRESSURE(DYNE/SC)	.33281E+06	PRESSURE(DYNE/SC)	.77864E+06
VIRIAL(CC/MOLE)	-125.7	VIRIAL(CC/MOLE)	-6.3

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 324.03 PPM

CO2 MEASUREMENT -- RERUN AFTER TRANSFER OF SAMPLE OUT OF MANOMETER THEN BACK INTO MANOMETER
(2 MINUTE TRANSFER TIMES)

THIS MEASUREMENT WAS MADE ON 10 MAR 70 (TOTAL GAS) AND 12 MAR 70 (CO2)

OBTAINED FROM CO2 MEASUREMENT NO. 2 AND TOTAL GAS MEASUREMENT NO. 1

SUMMARY OF MANOMETRIC CO2 CONCENTRATIONS ON CYLINDER NO. 2399 RUN NO. 3

TOTAL GAS RUN NO.	CO2 RUN NO.	CONC.
1	1	323.99
1	2	324.03

NO. OF TESTED CYLINDER = 2399, RUN NO. 4 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.384 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = -0.127 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 624.113 MM AND 371.014 MM--TEMPERATURE WAS 19.36 DEG. C
MERCURY DENSITY WAS 13.5474 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 764.160 MM AND 173.552 MM--TEMPERATURE WAS 19.25 DEG. C
MERCURY DENSITY WAS 13.5477 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	19.36	TEMPERATURE(C)	19.25
PRESSURE(DYNE/SC)	.33537E+06	PRESSURE(DYNE/SC)	.78361E+06
VIRIAL(CC/MOLE)	-125.6	VIRIAL(CC/MOLE)	-6.2

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 324.46 PPM

THIS MEASUREMENT WAS MADE ON 12 MAR 70

OBTAINED FROM CO2 MEASUREMENT NO. 1 AND TOTAL GAS MEASUREMENT NO. 1

NO. OF TESTED CYLINDER = 2399 RUN NO. 4 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.384 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = -0.127 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 624.028 MM AND 371.001 MM--TEMPERATURE WAS 19.32 DEG. C
MERCURY DENSITY WAS 13.5475 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 764.160 MM AND 173.552 MM--TEMPERATURE WAS 19.25 DEG. C
MERCURY DENSITY WAS 13.5477 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	19.32	TEMPERATURE(C)	19.25
PRESSURE(DYNE/SC)	.33527E+06	PRESSURE(DYNE/SC)	.78361E+06
VIRIAL(CC/MOLE)	-125.5	VIRIAL(CC/MOLE)	-6.2

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 324.42 PPM

CO2 MEASUREMENT -- RERUN AFTER TRANSFER OF SAMPLE OUT OF MANOMETER THEN BACK INTO MANOMETER
(1 MINUTE TRANSFER TIMES)

THIS MEASUREMENT WAS MADE ON 12 MAR 70

OBTAINED FROM CO2 MEASUREMENT NO. 2 AND TOTAL GAS MEASUREMENT NO. 1

SUMMARY OF MANOMETRIC CO2 CONCENTRATIONS ON CYLINDER NO. 2399 RUN NO. 4

TOTAL GAS RUN NO.	CO2 RUN NO.	CONC.
1	1	324.46
1	2	324.42

NO. OF TESTED CYLINDER = 2399, RUN NO. 5 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.330 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = -0.104 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 627.755 MM AND 370.962 MM--TEMPERATURE WAS 20.16 DEG. C
MERCURY DENSITY WAS 13.5455 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 773.375 MM AND 173.374 MM--TEMPERATURE WAS 20.04 DEG. C
MERCURY DENSITY WAS 13.5457 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	20.16	TEMPERATURE(C)	20.04
PRESSURE(DYNE/SC)	.34029E+06	PRESSURE(DYNE/SC)	.79599E+06
VIRIAL(CC/MOLE)	-127.5	VIRIAL(CC/MOLE)	-6.1

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 324.10 PPM

THIS MEASUREMENT WAS MADE ON 23 APR 70

OBTAINED FROM CO2 MEASUREMENT NO. 1 AND TOTAL GAS MEASUREMENT NO. 1

NO. OF TESTED CYLINDER = 2399 RUN NO. 5 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.330 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = -0.104 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 627.410 MM AND 370.948 MM--TEMPERATURE WAS 19.88 DEG. C
MERCURY DENSITY WAS 13.5451 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 773.375 MM AND 173.374 MM--TEMPERATURE WAS 20.04 DEG. C
MERCURY DENSITY WAS 13.5457 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	19.85	TEMPERATURE(C)	20.04
PRESSURE(DYNE/SC)	.33987E+06	PRESSURE(DYNE/SC)	.79599E+06
VIRIAL(CC/MOLE)	-125.1	VIRIAL(CC/MOLE)	-6.1

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 324.01 PPM

CO2 MEASUREMENT -- RERUN AFTER TRANSFER OF SAMPLE OUT OF MANOMETER THEN BACK INTO MANOMETER
(1 MINUTE TRANSFER TIMES)

THIS MEASUREMENT WAS MADE ON 23 APR 70 (TOTAL GAS) AND 24 APR 70 (CO2)

OBTAINED FROM CO2 MEASUREMENT NO. 2 AND TOTAL GAS MEASUREMENT NO. 1

SUMMARY OF MANOMETRIC CO2 CONCENTRATIONS ON CYLINDER NO. 2399 RUN NO. 5

TOTAL GAS RUN NO.	CO2 RUN NO.	CONC.
1	1	324.10
1	2	324.01

NO. OF TESTED CYLINDER = 2399, RUN NO. 6 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.330 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = -0.104 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 622.990 MM AND 370.970 MM--TEMPERATURE WAS 19.40 DEG. C
MERCURY DENSITY WAS 13.5473 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 762.994 MM AND 173.472 MM--TEMPERATURE WAS 19.60 DEG. C
MERCURY DENSITY WAS 13.5458 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	19.40	TEMPERATURE(C)	19.60
PRESSURE(DYNE/SC)	.33400E+06	PRESSURE(DYNE/SC)	.78215E+06
VIRIAL(CC/MOLE)	-125.5	VIRIAL(CC/MOLE)	-6.2

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 324.09 PPM

THIS MEASUREMENT WAS MADE ON 28 APR 70 (TOTAL GAS) AND 29 APR 70 (CO2)

OBTAINED FROM CO2 MEASUREMENT NO. 1 AND TOTAL GAS MEASUREMENT NO. 1

NO. OF TESTED CYLINDER = 2399, RUN NO. 6 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.330 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = -0.104 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 623.235 MM AND 370.973 MM--TEMPERATURE WAS 19.68 DEG. C
MERCURY DENSITY WAS 13.5456 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 762.994 MM AND 173.472 MM--TEMPERATURE WAS 19.60 DEG. C
MERCURY DENSITY WAS 13.5458 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	19.68	TEMPERATURE(C)	19.60
PRESSURE(DYNE/SC)	.33431E+06	PRESSURE(DYNE/SC)	.78215E+06
VIRIAL(CC/MOLE)	-128.3	VIRIAL(CC/MOLE)	-6.2

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 324.07 PPM

CO2 MEASUREMENT -- RERUN AFTER TRANSFER OF SAMPLE OUT OF MANOMETER THEN BACK INTO MANOMETER
(1 MINUTE TRANSFER TIMES)

THIS MEASUREMENT WAS MADE ON 28 APR 70 (TOTAL GAS) AND 29 APR 70 (CO2)

OBTAINED FROM CO2 MEASUREMENT NO. 2 AND TOTAL GAS MEASUREMENT NO. 1

SUMMARY OF MANOMETRIC CO2 CONCENTRATIONS ON CYLINDER NO. 2399 RUN NO. 6

TOTAL GAS RUN NO.	CO2 RUN NO.	CONC.
1	1	324.09
1	2	324.07

NO. OF TESTED CYLINDER = 2399 RUN NO. 7 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.444 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = 0.000 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 624.333 MM AND 370.965 MM--TEMPERATURE WAS 20.09 DEG. C
MERCURY DENSITY WAS 13.5456 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 764.334 MM AND 173.561 MM--TEMPERATURE WAS 19.66 DEG. C
MERCURY DENSITY WAS 13.5467 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	20.09	TEMPERATURE(C)	19.66
PRESSURE(DYNE/SC)	.33360E+06	PRESSURE(DYNE/SC)	.78394E+06
VIRIAL(CC/MOLE)	-127.9	VIRIAL(CC/MOLE)	-6.1

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 324.19 PPM

CO2 MEASUREMENT -- TRANSFER TIMES OF 3 MINUTES WITH DRY ICE FROM HERE ON

THIS MEASUREMENT WAS MADE ON 13 MAY 70

OBTAINED FROM CO2 MEASUREMENT NO. 1 AND TOTAL GAS MEASUREMENT NO. 1

NO. OF TESTED CYLINDER = 2399 RUN NO. 7 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.444 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = 0.000 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 623.965 MM AND 370.947 MM--TEMPERATURE WAS 19.68 DEG. C
MERCURY DENSITY WAS 13.5456 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 764.334 MM AND 173.561 MM--TEMPERATURE WAS 19.66 DEG. C
MERCURY DENSITY WAS 13.5457 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	19.68	TEMPERATURE(C)	19.66
PRESSURE(DYNE/SC)	.33516E+06	PRESSURE(DYNE/SC)	.78394E+06
VIRIAL(CC/MOLE)	-128.3	VIRIAL(CC/MOLE)	-6.1

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 324.22 PPM

CO2 MEASUREMENT -- RERUN AFTER TRANSFER OF SAMPLE OUT OF MANOMETER THEN BACK INTO MANOMETER
(1 MINUTE TRANSFER TIMES)

THIS MEASUREMENT WAS MADE ON 13 MAY 70 (TOTAL GAS) AND 14 MAY 70 (CO2)

OBTAINED FROM CO2 MEASUREMENT NO. 2 AND TOTAL GAS MEASUREMENT NO. 1

SUMMARY OF MANOMETRIC CO2 CONCENTRATIONS ON CYLINDER NO. 2399 RUN NO. 7

TOTAL GAS RUN NO.	CO2 RUN NO.	CONC.
1	1	324.19
1	2	324.22

NO. OF TESTED CYLINDER = 2399 RUN NO. 8 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.444 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = 0.000 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 623.445 MM AND 370.956 MM--TEMPERATURE WAS 20.17 DEG. C
MERCURY DENSITY WAS 13.5454 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 762.927 MM AND 173.588 MM--TEMPERATURE WAS 19.85 DEG. C
MERCURY DENSITY WAS 13.5462 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	20.17	TEMPERATURE(C)	19.85
PRESSURE(DYNE/SC)	.33443E+06	PRESSURE(DYNE/SC)	.78201E+06
VIRIAL(CC/MOLE)	-127.3	VIRIAL(CC/MOLE)	-6.1

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 323.98 PPM

THIS MEASUREMENT WAS MADE ON 15 MAY 70

OBTAINED FROM CO2 MEASUREMENT NO. 1 AND TOTAL GAS MEASUREMENT NO. 1

NO. OF TESTED CYLINDER = 23997 RUN NO. 8 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.444 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = 0.000 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 623.625 MM AND 370.949 MM--TEMPERATURE WAS 20.44 DEG. C
MERCURY DENSITY WAS 13.5448 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 762.927 MM AND 173.588 MM--TEMPERATURE WAS 19.85 DEG. C
MERCURY DENSITY WAS 13.5462 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	20.44	TEMPERATURE(C)	19.85
PRESSURE(DYNE/SC)	.33466E+06	PRESSURE(DYNE/SC)	.78201E+06
VIRIAL(CC/MOLE)	-127.5	VIRIAL(CC/MOLE)	-6.1

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 323.90 PPM

CO2 MEASUREMENT -- RERUN AFTER TRANSFER OF SAMPLE OUT OF MANOMETER THEN BACK INTO MANOMETER
(1 MINUTE TRANSFER TIMES)

THIS MEASUREMENT WAS MADE ON 15 MAY 70

OBTAINED FROM CO2 MEASUREMENT NO. 2 AND TOTAL GAS MEASUREMENT NO. 1

SUMMARY OF MANOMETRIC CO2 CONCENTRATIONS ON CYLINDER NO. 2399 RUN NO. 8

TOTAL GAS RUN NO.	CO2 RUN NO.	CONC.
1	1	323.98
1	2	323.90

NO. OF TESTED CYLINDER = 6076, RUN NO. 6 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.430 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = -0.070 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 618.844 MM AND 374.697 MM--TEMPERATURE WAS 20.01 DEG. C
MERCURY DENSITY WAS 13.5458 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 772.173 MM AND 177.232 MM--TEMPERATURE WAS 20.15 DEG. C
MERCURY DENSITY WAS 13.5455 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	20.01	TEMPERATURE(C)	20.15
PRESSURE(DYNE/SC)	.32339E+06	PRESSURE(DYNE/SC)	.78931E+06
VIRIAL(CC/MOLE)	-128.0	VIRIAL(CC/MOLE)	-6.0

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 310.86 PPM

CO2 MEASUREMENT -- TRANSFERS USING LIQUID-SOLID ETHANOL

THIS MEASUREMENT WAS MADE ON 1 DEC 69 (TOTAL GAS) AND 2 DEC 69 (CO2)

OBTAINED FROM CO2 MEASUREMENT NO. 1 AND TOTAL GAS MEASUREMENT NO. 1

NO. OF TESTED CYLINDER = 5076 RUN NO. 6 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.430 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = -0.070 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 618.899 MM AND 374.646 MM--TEMPERATURE WAS 20.09 DEG. C
MERCURY DENSITY WAS 13.5456 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 772.173 MM AND 177.232 MM--TEMPERATURE WAS 20.15 DEG. C
MERCURY DENSITY WAS 13.5455 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	20.09	TEMPERATURE(C)	20.15
PRESSURE(DYNE/SC)	.32352E+06	PRESSURE(DYNE/SC)	.78931E+06
VIRIAL(CC/MOLE)	-127.9	VIRIAL(CC/MOLE)	-6.0

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 310.90 PPM

CO2 MEASUREMENT -- RERUN AFTER TRANSFER OF SAMPLE OUT OF MANOMETER THEN BACK INTO MANOMETER USING LIQUID-SOLID ETHANOL.

THIS MEASUREMENT WAS MADE ON 1 DEC 69 (TOTAL GAS) AND 2 DEC 69 (CO2)

OBTAINED FROM CO2 MEASUREMENT NO. 2 AND TOTAL GAS MEASUREMENT NO. 1

SUMMARY OF MANOMETRIC CO2 CONCENTRATIONS ON CYLINDER NO. 6078 RUN NO. 6

TOTAL GAS RUN NO.	CO2 RUN NO.	CONC.
1	1	310.86
1	2	310.90

NO. OF TESTED CYLINDER = 6078. RUN NO. 7 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.430 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = -0.070 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 618.124 MM AND 374.682 MM--TEMPERATURE WAS 19.91 DEG. C
MERCURY DENSITY WAS 13.5461 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 769.870 MM AND 177.252 MM--TEMPERATURE WAS 19.91 DEG. C
MERCURY DENSITY WAS 13.5461 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	19.91	TEMPERATURE(C)	19.91
PRESSURE(DYNE/SC)	.32246E+06	PRESSURE(DYNE/SC)	.78626E+06
VIRIAL(CC/MOLE)	-128.1	VIRIAL(CC/MOLE)	-6.1

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 311.01 PPM

CO2 MEASUREMENT -- TRANSFERS USING LIQUID-SOLID ETHANOL

THIS MEASUREMENT WAS MADE ON 2 DEC 69

OBTAINED FROM CO2 MEASUREMENT NO. 1 AND TOTAL GAS MEASUREMENT NO. 1

NO. OF TESTED CYLINDER = 6078 RUN NO. 7 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.430 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = -0.070 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 618.472 MM AND 374.684 MM--TEMPERATURE WAS 20.24 DEG. C
MERCURY DENSITY WAS 13.5453 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 769.870 MM AND 177.252 MM--TEMPERATURE WAS 19.91 DEG. C
MERCURY DENSITY WAS 13.5461 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	20.24	TEMPERATURE(C)	19.91
PRESSURE(DYNE/SC)	.32290E+06	PRESSURE(DYNE/SC)	.78626E+06
VIRIAL(CC/MOLE)	-127.7	VIRIAL(CC/MOLE)	-6.1

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 311.09 PPM

CO2 MEASUREMENT -- RERUN AFTER TRANSFER OF SAMPLE OUT OF MANOMETER THEN BACK INTO MANOMETER USING LIQUID-SOLID ETHANOL.

THIS MEASUREMENT WAS MADE ON 2 DEC 69 (TOTAL GAS) AND 3 DEC 69 (CO2)

OBTAINED FROM CO2 MEASUREMENT NO. 2 AND TOTAL GAS MEASUREMENT NO. 1

SUMMARY OF MANOMETRIC CO2 CONCENTRATIONS ON CYLINDER NO. 6078 RUN NO. 7

TOTAL GAS RUN NO.	CO2 RUN NO.	CONC.
1	1	311.01
1	2	311.09

NO. OF TESTED CYLINDER = 5078 RUN NO. 8 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.430 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = -0.070 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 617.370 MM AND 374.774 MM--TEMPERATURE WAS 19.88 DEG. C
MERCURY DENSITY WAS 13.5461 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 768.700 MM AND 177.370 MM--TEMPERATURE WAS 19.89 DEG. C
MERCURY DENSITY WAS 13.5461 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	19.88	TEMPERATURE(C)	19.89
PRESSURE(DYNE/SC)	.32134E+06	PRESSURE(DYNE/SC)	.78455E+06
VIRIAL(CC/MOLE)	-128.1	VIRIAL(CC/MOLE)	-6.1

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 310.62 PPM

CO2 MEASUREMENT -- TRANSFERS USING LIQUID-SOLID ETHANOL(10 MINUTE TRANSFER TIMES)

THIS MEASUREMENT WAS MADE ON 8 DEC 69 (TOTAL GAS) AND 9 DEC 69 (CO2)

OBTAINED FROM CO2 MEASUREMENT NO. 1 AND TOTAL GAS MEASUREMENT NO. 1

NO. OF TESTED CYLINDER = 6078. RUN NO. 8 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.430 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = -0.070 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 617.566 MM AND 374.779 MM--TEMPERATURE WAS 20.18 DEG. C
MERCURY DENSITY WAS 13.5454 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 768.700 MM AND 177.370 MM--TEMPERATURE WAS 19.89 DEG. C
MERCURY DENSITY WAS 13.5461 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	20.15	TEMPERATURE(C)	19.89
PRESSURE(DYNE/SC)	.32157E+06	PRESSURE(DYNE/SC)	.78455E+06
VIRIAL(CC/MOLE)	-127.8	VIRIAL(CC/MOLE)	-6.1

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 310.53 PPM

CO2 MEASUREMENT -- RERUN AFTER TRANSFER OF SAMPLE OUT OF MANOMETER THEN BACK INTO MANOMETER USING LIQUID-SOLID ETHANOL(5 MINUTE TRANSFER TIMES)

THIS MEASUREMENT WAS MADE ON 8 DEC 69 (TOTAL GAS) AND 9 DEC 69 (CO2)

OBTAINED FROM CO2 MEASUREMENT NO. 2 AND TOTAL GAS MEASUREMENT NO. 1

SUMMARY OF MANOMETRIC CO2 CONCENTRATIONS ON CYLINDER NO. 6078 RUN NO. 8

TOTAL GAS RUN NO.	CO2 RUN NO.	CONC.
1	1	310.62
1	2	310.53

NO. OF TESTED CYLINDER = 6076, RUN NO. 9 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.430 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = -0.070 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 616.716 MM AND 374.621 MM--TEMPERATURE WAS 19.26 DEG. C
MERCURY DENSITY WAS 13.5477 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 767.572 MM AND 177.315 MM--TEMPERATURE WAS 19.68 DEG. C
MERCURY DENSITY WAS 13.5466 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	19.26	TEMPERATURE(C)	19.68
PRESSURE(DYNE/SC)	.32071E+06	PRESSURE(DYNE/SC)	.78316E+06
VIRIAL(CC/MOLE)	-128.7	VIRIAL(CC/MOLE)	-6.1

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 311.00 PPM

CO2 MEASUREMENT -- TRANSFERS USING DRY ICE (4 MINUTE TRANSFER TIMES)

THIS MEASUREMENT WAS MADE ON 9 DEC 69 (TOTAL GAS) AND 10 DEC 69 (CO2)

OBTAINED FROM CO2 MEASUREMENT NO. 1 AND TOTAL GAS MEASUREMENT NO. 1

NO. OF TESTED CYLINDER = 6078, RUN NO. 9 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.430 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = -0.070 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 617.249 MM AND 374.620 MM--TEMPERATURE WAS 19.99 DEG. C
MERCURY DENSITY WAS 13.5459 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 767.572 MM AND 177.315 MM--TEMPERATURE WAS 19.68 DEG. C
MERCURY DENSITY WAS 13.5466 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	19.99	TEMPERATURE(C)	19.68
PRESSURE(DYNE/SC)	.32137E+06	PRESSURE(DYNE/SC)	.78316E+06
VIRIAL(CC/MOLE)	-125.0	VIRIAL(CC/MOLE)	-6.1

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 310.86 PPM

CO2 MEASUREMENT -- RERUN AFTER TRANSFER OF SAMPLE OUT OF MANOMETER THEN BACK INTO MANOMETER USING DRY ICE(4 MINUTE TRANSFER TIMES)

THIS MEASUREMENT WAS MADE ON 9 DEC 69 (TOTAL GAS) AND 10 DEC 69 (CO2)

OBTAINED FROM CO2 MEASUREMENT NO. 2 AND TOTAL GAS MEASUREMENT NO. 1

SUMMARY OF MANOMETRIC CO2 CONCENTRATIONS ON CYLINDER NO. 6078 RUN NO. 9

TOTAL GAS RUN NO.	CO2 RUN NO.	CONC.
1	1	311.00
1	2	310.86

NO. OF TESTED CYLINDER = 6078 RUN NO. 10 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.430 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = -0.070 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 620.472 MM AND 374.621 MM--TEMPERATURE WAS 19.86 DEG. C
MERCURY DENSITY WAS 13.5462 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 774.840 MM AND 177.182 MM--TEMPERATURE WAS 19.39 DEG. C
MERCURY DENSITY WAS 13.5474 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	19.86	TEMPERATURE(C)	19.39
PRESSURE(DYNE/SC)	.32566E+06	PRESSURE(DYNE/SC)	.79302E+06
VIRIAL(CC/MOLE)	-125.1	VIRIAL(CC/MOLE)	-6.2

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 310.93 PPM

CO2 MEASUREMENT -- TRANSFERS USING LIQUID-SOLID ETHANOL(5 MINUTE TRANSFER TIMES)

THIS MEASUREMENT WAS MADE ON 11 DEC 69

OBTAINED FROM CO2 MEASUREMENT NO. 1 AND TOTAL GAS MEASUREMENT NO. 1

NO. OF TESTED CYLINDER = 6078, RUN NO. 10 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.430 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = -0.070 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 620.165 MM AND 374.629 MM--TEMPERATURE WAS 19.62 DEG. C
MERCURY DENSITY WAS 13.5468 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 774.840 MM AND 177.182 MM--TEMPERATURE WAS 19.39 DEG. C
MERCURY DENSITY WAS 13.5474 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	19.62	TEMPERATURE(C)	19.39
PRESSURE(DYNE/SC)	.32525E+06	PRESSURE(DYNE/SC)	.79302E+06
VIRIAL(CC/MOLE)	-128.4	VIRIAL(CC/MOLE)	-6.2

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 310.80 PPM

CO2 MEASUREMENT -- RERUN AFTER TRANSFER OF SAMPLE OUT OF MANOMETER THEN BACK INTO MANOMETER USING LIQUID-SOLID ETHANOL(3 MINUTE TRANSFER TIMES)

THIS MEASUREMENT WAS MADE ON 11 DEC 69 (TOTAL GAS) AND 12 DEC 69 (CO2)

OBTAINED FROM CO2 MEASUREMENT NO. 2 AND TOTAL GAS MEASUREMENT NO. 1

SUMMARY OF MANOMETRIC CO2 CONCENTRATIONS ON CYLINDER NO. 6078 RUN NO. 10

TOTAL GAS RUN NO.	CO2 RUN NO.	CONC.
1	1	310.93
1	2	310.80

NO. OF TESTED CYLINDER = 6078 RUN NO. 11 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.384 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = -0.127 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 613.548 MM AND 371.014 MM--TEMPERATURE WAS 19.19 DEG. C
MERCURY DENSITY WAS 13.5479 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 764.348 MM AND 173.649 MM--TEMPERATURE WAS 19.30 DEG. C
MERCURY DENSITY WAS 13.5476 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	19.19	TEMPERATURE(C)	19.30
PRESSURE(DYNE/SC)	.32136E+06	PRESSURE(DYNE/SC)	.78373E+06
VIRIAL(CC/MOLE)	-125.8	VIRIAL(CC/MOLE)	-6.2

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 311.07 PPM

CO2 MEASUREMENT -- TRANSFERS USING DRY ICE FROM HERE ON (5 MINUTE TRANSFER TIMES)

THIS MEASUREMENT WAS MADE ON 9 MAR 70 (TOTAL GAS) AND 10 MAR 70 (CO2)

OBTAINED FROM CO2 MEASUREMENT NO. 1 AND TOTAL GAS MEASUREMENT NO. 1

NO. OF TESTED CYLINDER = 6078 RUN NO. 11 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.384 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = -0.127 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 613.381 MM AND 370.996 MM--TEMPERATURE WAS 19.13 DEG. C
MERCURY DENSITY WAS 13.5450 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 764.348 MM AND 173.649 MM--TEMPERATURE WAS 19.30 DEG. C
MERCURY DENSITY WAS 13.5476 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	19.13	TEMPERATURE(C)	19.30
PRESSURE(DYNE/SC)	.32116E+06	PRESSURE(DYNE/SC)	.78373E+06
VIRIAL(CC/MOLE)	-128.6	VIRIAL(CC/MOLE)	-6.2

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 310.95 PPM

CO2 MEASUREMENT -- RERUN AFTER TRANSFER OF SAMPLE OUT OF MANOMETER THEN BACK INTO MANOMETER USING DRY ICE FROM HERE ON(2 MINUTE TRANSFER TIMES)

THIS MEASUREMENT WAS MADE ON 9 MAR 70 (TOTAL GAS) AND 10 MAR 70 (CO2)

OBTAINED FROM CO2 MEASUREMENT NO. 2 AND TOTAL GAS MEASUREMENT NO. 1

SUMMARY OF MANOMETRIC CO2 CONCENTRATIONS ON CYLINDER NO. 6078 RUN NO. 11

TOTAL GAS RUN NO.	CO2 RUN NO.	CONC.
1	1	311.07
1	2	310.95

NO. OF TESTED CYLINDER = 5078 RUN NO. 12 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.444 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = 0.000 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 612.586 MM AND 370.998 MM--TEMPERATURE WAS 19.73 DEG. C
MERCURY DENSITY WAS 13.5465 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 762.000 MM AND 173.492 MM--TEMPERATURE WAS 20.09 DEG. C
MERCURY DENSITY WAS 13.5456 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	19.73	TEMPERATURE(C)	20.09
PRESSURE(DYNE/SC)	.31999E+06	PRESSURE(DYNE/SC)	.78087E+06
VIRIAL(CC/MOLE)	-129.2	VIRIAL(CC/MOLE)	-6.1

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 311.14 PPM

THIS MEASUREMENT WAS MADE ON 14 MAY 70 (TOTAL GAS) AND 15 MAY 70 (CO2)

OBTAINED FROM CO2 MEASUREMENT NO. 1 AND TOTAL GAS MEASUREMENT NO. 1

NO. OF TESTED CYLINDER = 5078 RUN NO. 12 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.444 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = 0.000 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 612.607 MM AND 370.976 MM--TEMPERATURE WAS 19.81 DEG. C
MERCURY DENSITY WAS 13.5453 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 762.000 MM AND 173.492 MM--TEMPERATURE WAS 20.09 DEG. C
MERCURY DENSITY WAS 13.5456 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	19.81	TEMPERATURE(C)	20.09
PRESSURE(DYNE/SC)	.32004E+06	PRESSURE(DYNE/SC)	.78087E+06
VIRIAL(CC/MOLE)	-128.2	VIRIAL(CC/MOLE)	-6.1

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 311.11 PPM

CO2 MEASUREMENT -- RERUN AFTER TRANSFER OF SAMPLE OUT OF MANOMETER THEN BACK INTO MANOMETER
(1 MINUTE TRANSFER TIMES)

THIS MEASUREMENT WAS MADE ON 14 MAY 70 (TOTAL GAS) AND 15 MAY 70 (CO2)

OBTAINED FROM CO2 MEASUREMENT NO. 2 AND TOTAL GAS MEASUREMENT NO. 1

SUMMARY OF MANOMETRIC CO2 CONCENTRATIONS ON CYLINDER NO. 6078 RUN NO. 12

TOTAL GAS RUN NO.	CO2 RUN NO.	CONC.
1	1	311.14
1	2	311.11

NO. OF TESTED CYLINDER = 7366, RUN NO. 1 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.444 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = 0.000 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 585.092 MM AND 370.982 MM--TEMPERATURE WAS 19.98 DEG. C
MERCURY DENSITY WAS 13.5459 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 759.159 MM AND 173.600 MM--TEMPERATURE WAS 19.80 DEG. C
MERCURY DENSITY WAS 13.5453 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	19.98	TEMPERATURE(C)	19.80
PRESSURE(DYNE/SC)	.28351E+06	PRESSURE(DYNE/SC)	.77700E+06
VIRIAL(CC/MOLE)	-129.0	VIRIAL(CC/MOLE)	-6.1

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 276.48 PPM

THIS MEASUREMENT WAS MADE ON 11 MAY 70

OBTAINED FROM CO2 MEASUREMENT NO. 1 AND TOTAL GAS MEASUREMENT NO. 1

NO. OF TESTED CYLINDER = 7366 RUN NO. 1 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.444 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = 0.000 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 584.772 MM AND 371.005 MM--TEMPERATURE WAS 19.67 DEG. C
MERCURY DENSITY WAS 13.5467 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 759.159 MM AND 173.600 MM--TEMPERATURE WAS 19.80 DEG. C
MERCURY DENSITY WAS 13.5463 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	19.67	TEMPERATURE(C)	19.80
PRESSURE(DYNE/SC)	.28307E+06	PRESSURE(DYNE/SC)	.77700E+06
VIRIAL(CC/MOLE)	-125.3	VIRIAL(CC/MOLE)	-6.1

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 276.35 PPM

CO2 MEASUREMENT -- RERUN AFTER TRANSFER OF SAMPLE OUT OF MANOMETER THEN BACK INTO MANOMETER
(1 MINUTE TRANSFER TIMES)

THIS MEASUREMENT WAS MADE ON 11 MAY 70 (TOTAL GAS) AND 12 MAY 70 (CO2)

OBTAINED FROM CO2 MEASUREMENT NO. 2 AND TOTAL GAS MEASUREMENT NO. 1

SUMMARY OF MANOMETRIC CO2 CONCENTRATIONS ON CYLINDER NO. 7366 RUN NO. 1

TOTAL GAS RUN NO.	CO2 RUN NO.	CONC.
1	1	276.48
1	2	276.35

NO. OF TESTED CYLINDER = 7360 RUN NO. 2 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.444 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = 0.000 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 587.199 MM AND 370.962 MM--TEMPERATURE WAS 19.65 DEG. C
MERCURY DENSITY WAS 13.5457 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 765.191 MM AND 173.633 MM--TEMPERATURE WAS 19.66 DEG. C
MERCURY DENSITY WAS 13.5457 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	19.65	TEMPERATURE(C)	19.66
PRESSURE(DYNE/SC)	.28535E+06	PRESSURE(DYNE/SC)	.78498E+06
VIRIAL(CC/MOLE)	-125.3	VIRIAL(CC/MOLE)	-6.1

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 276.60 PPM

THIS MEASUREMENT WAS MADE ON 12 MAY 70

OBTAINED FROM CO2 MEASUREMENT NO. 1 AND TOTAL GAS MEASUREMENT NO. 1

NO. OF TESTED CYLINDER = 7366 RUN NO. 2 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.444 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = 0.000 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 587.418 MM AND 370.971 MM--TEMPERATURE WAS 19.91 DEG. C
MERCURY DENSITY WAS 13.5451 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 765.191 MM AND 173.633 MM--TEMPERATURE WAS 19.66 DEG. C
MERCURY DENSITY WAS 13.5457 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	19.91	TEMPERATURE(C)	19.66
PRESSURE(DYNE/SC)	.28362E+06	PRESSURE(DYNE/SC)	.78498E+06
VIRIAL(CC/MOLE)	-128.1	VIRIAL(CC/MOLE)	-6.1

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 276.61 PPM

CO2 MEASUREMENT -- RERUN AFTER TRANSFER OF SAMPLE OUT OF MANOMETER THEN BACK INTO MANOMETER
(1 MINUTE TRANSFER TIMES)

THIS MEASUREMENT WAS MADE ON 12 MAY 70

OBTAINED FROM CO2 MEASUREMENT NO. 2 AND TOTAL GAS MEASUREMENT NO. 1

SUMMARY OF MANOMETRIC CO2 CONCENTRATIONS ON CYLINDER NO. 7366 RUN NO. 2

TOTAL GAS RUN NO.	CO2 RUN NO.	CONC.
1	1	276.60
1	2	276.61

NO. OF TESTED CYLINDER = 7366, RUN NO. 3 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.444 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = 0.000 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 588.257 MM AND 370.974 MM--TEMPERATURE WAS 19.74 DEG. C
MERCURY DENSITY WAS 13.5455 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 768.269 MM AND 173.495 MM--TEMPERATURE WAS 19.94 DEG. C
MERCURY DENSITY WAS 13.5450 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	19.74	TEMPERATURE(C)	19.94
PRESSURE(DYNE/SC)	.28774E+06	PRESSURE(DYNE/SC)	.78921E+06
VIRIAL(CC/MOLE)	-128.2	VIRIAL(CC/MOLE)	-6.1

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 276.63 PPM

THIS MEASUREMENT WAS MADE ON 12 MAY 70 (TOTAL GAS) AND 13 MAY 70 (CO2)

OBTAINED FROM CO2 MEASUREMENT NO. 1 AND TOTAL GAS MEASUREMENT NO. 1

NO. OF TESTED CYLINDER = 7365 RUN NO. 3 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.444 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = 0.000 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 588.190 MM AND 370.949 MM--TEMPERATURE WAS 19.75 DEG. C
MERCURY DENSITY WAS 13.5465 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 768.269 MM AND 173.495 MM--TEMPERATURE WAS 19.94 DEG. C
MERCURY DENSITY WAS 13.5450 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	19.75	TEMPERATURE(C)	19.94
PRESSURE(DYNE/SC)	.28768E+06	PRESSURE(DYNE/SC)	.78921E+06
VIRIAL(CC/MOLE)	-125.2	VIRIAL(CC/MOLE)	-6.1

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 276.56 PPM

CO2 MEASUREMENT -- RERUN AFTER TRANSFER OF SAMPLE OUT OF MANOMETER THEN BACK INTO MANOMETER
(1 MINUTE TRANSFER TIMES)

THIS MEASUREMENT WAS MADE ON 12 MAY 70 (TOTAL GAS) AND 13 MAY 70 (CO2)

OBTAINED FROM CO2 MEASUREMENT NO. 2 AND TOTAL GAS MEASUREMENT NO. 1

SUMMARY OF MANOMETRIC CO2 CONCENTRATIONS ON CYLINDER NO. 7366 RUN NO. 3

TOTAL GAS RUN NO.	CO2 RUN NO.	CONC.
1	1	276.63
1	2	276.56

NO. OF TESTED CYLINDER = 10069 RUN NO. 1 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.430 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = -0.070 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 652.387 MM AND 374.613 MM--TEMPERATURE WAS 18.75 DEG. C
MERCURY DENSITY WAS 13.5490 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 771.326 MM AND 177.243 MM--TEMPERATURE WAS 19.95 DEG. C
MERCURY DENSITY WAS 13.5460 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	18.75	TEMPERATURE(C)	19.95
PRESSURE(DYNE/SC)	.36809E+06	PRESSURE(DYNE/SC)	.78820E+06
VIRIAL(CC/MOLE)	-129.2	VIRIAL(CC/MOLE)	-6.1

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 355.71 PPM

CO2 MEASUREMENT -- TRANSFERS USING LIQUID-SOLID ETHANOL(5 MINUTE TRANSFER TIMES)

THIS MEASUREMENT WAS MADE ON 10 DEC 69 (TOTAL GAS) AND 11 DEC 69 (CO2)

OBTAINED FROM CO2 MEASUREMENT NO. 1 AND TOTAL GAS MEASUREMENT NO. 1

NO. OF TESTED CYLINDER = 13069, RUN NO. 1 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.430 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = -0.070 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 653.019 MM AND 374.594 MM--TEMPERATURE WAS 19.53 DEG. C
MERCURY DENSITY WAS 13.5470 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 771.326 MM AND 177.243 MM--TEMPERATURE WAS 19.95 DEG. C
MERCURY DENSITY WAS 13.5460 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	19.53	TEMPERATURE(C)	19.95
PRESSURE(DYNE/SC)	.36590E+06	PRESSURE(DYNE/SC)	.78820E+06
VIRIAL(CC/MOLE)	-128.4	VIRIAL(CC/MOLE)	-6.1

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 355.54 PPM

CO2 MEASUREMENT -- RERUN AFTER TRANSFER OF SAMPLE OUT OF MANOMETER THEN BACK INTO MANOMETER USING LIQUID-SOLID ETHANOL(5 MINUTE TRANSFER TIMES)

THIS MEASUREMENT WAS MADE ON 10 DEC 69 (TOTAL GAS) AND 11 DEC 69 (CO2)

OBTAINED FROM CO2 MEASUREMENT NO. 2 AND TOTAL GAS MEASUREMENT NO. 1

SUMMARY OF MANOMETRIC CO2 CONCENTRATIONS ON CYLINDER NO. 10069 RUN NO. 1

TOTAL GAS RUN NO.	CO2 RUN NO.	CONC.
1	1	355.71
1	2	355.54

NO. OF TESTED CYLINDER = 10069, RUN NO. 2 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.330 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = -0.104 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 649.408 MM AND 370.963 MM--TEMPERATURE WAS 20.03 DEG. C
MERCURY DENSITY WAS 13.5458 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 766.329 MM AND 173.512 MM--TEMPERATURE WAS 19.88 DEG. C
MERCURY DENSITY WAS 13.5451 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	20.03	TEMPERATURE(C)	19.88
PRESSURE(DYNE/SC)	.36903E+06	PRESSURE(DYNE/SC)	.78648E+06
VIRIAL(CC/MOLE)	-128.0	VIRIAL(CC/MOLE)	-6.1

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 355.74 PPM

THIS MEASUREMENT WAS MADE ON 24 APR 70

OBTAINED FROM CO2 MEASUREMENT NO. 1 AND TOTAL GAS MEASUREMENT NO. 1

NO. OF TESTED CYLINDER = 10069, RUN NO. 2 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.330 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = -0.104 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 649.137 MM AND 370.943 MM--TEMPERATURE WAS 19.86 DEG. C
MERCURY DENSITY WAS 13.5462 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 766.329 MM AND 173.512 MM--TEMPERATURE WAS 19.88 DEG. C
MERCURY DENSITY WAS 13.5461 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	19.86	TEMPERATURE(C)	19.88
PRESSURE(DYNE/SC)	.36871E+06	PRESSURE(DYNE/SC)	.78648E+06
VIRIAL(CC/MOLE)	-125.1	VIRIAL(CC/MOLE)	-6.1

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 355.63 PPM

CO2 MEASUREMENT -- RERUN AFTER TRANSFER OF SAMPLE OUT OF MANOMETER THEN BACK INTO MANOMETER
(1 MINUTE TRANSFER TIMES)

THIS MEASUREMENT WAS MADE ON 24 APR 70

OBTAINED FROM CO2 MEASUREMENT NO. 2 AND TOTAL GAS MEASUREMENT NO. 1

SUMMARY OF MANOMETRIC CO2 CONCENTRATIONS ON CYLINDER NO. 10069 RUN NO. 2

TOTAL GAS RUN NO.	CO2 RUN NO.	CONC.
1	1	355.74
1	2	355.63

NO. OF TESTED CYLINDER = 10069, RUN NO. 3 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.330 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = -0.104 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 651.634 MM AND 370.944 MM--TEMPERATURE WAS 19.56 DEG. C
MERCURY DENSITY WAS 13.5459 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 771.880 MM AND 173.519 MM--TEMPERATURE WAS 19.54 DEG. C
MERCURY DENSITY WAS 13.5470 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	19.56	TEMPERATURE(C)	19.54
PRESSURE(DYNE/SC)	.37204E+06	PRESSURE(DYNE/SC)	.79389E+06
VIRIAL(CC/MOLE)	-125.4	VIRIAL(CC/MOLE)	-6.2

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 355.46 PPM

THIS MEASUREMENT WAS MADE ON 27 APR 70 (TOTAL GAS) AND 28 APR 70 (CO2)

OBTAINED FROM CO2 MEASUREMENT NO. 1 AND TOTAL GAS MEASUREMENT NO. 1

NO. OF TESTED CYLINDER = 10069, RUN NO. 3 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.330 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = -0.104 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 651.895 MM AND 370.964 MM--TEMPERATURE WAS 19.71 DEG. C
MERCURY DENSITY WAS 13.5456 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 771.880 MM AND 173.519 MM--TEMPERATURE WAS 19.54 DEG. C
MERCURY DENSITY WAS 13.5470 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	19.71	TEMPERATURE(C)	19.54
PRESSURE(DYNE/SC)	.37235E+06	PRESSURE(DYNE/SC)	.79389E+06
VIRIAL(CC/MOLE)	-123.3	VIRIAL(CC/MOLE)	-6.2

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 355.57 PPM

CO2 MEASUREMENT -- RERUN AFTER TRANSFER OF SAMPLE OUT OF MANOMETER THEN BACK INTO MANOMETER
(1 MINUTE TRANSFER TIMES)

THIS MEASUREMENT WAS MADE ON 27 APR 70 (TOTAL GAS) AND 28 APR 70 (CO2)

OBTAINED FROM CO2 MEASUREMENT NO. 2 AND TOTAL GAS MEASUREMENT NO. 1

SUMMARY OF MANOMETRIC CO2 CONCENTRATIONS ON CYLINDER NO. 10069 RUN NO. 3

TOTAL GAS RUN NO.	CO2 RUN NO.	CONC.
1	1	355.46
1	2	355.57

NO. OF TESTED CYLINDER = 10069 RUN NO. 4 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.444 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = 0.000 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 646.598 MM AND 370.962 MM--TEMPERATURE WAS 19.73 DEG. C
MERCURY DENSITY WAS 13.5455 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 760.347 MM AND 173.545 MM--TEMPERATURE WAS 19.67 DEG. C
MERCURY DENSITY WAS 13.5457 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	19.73	TEMPERATURE(C)	19.67
PRESSURE(DYNE/SC)	.36517E+06	PRESSURE(DYNE/SC)	.77867E+06
VIRIAL(CC/MOLE)	-129.2	VIRIAL(CC/MOLE)	-6.1

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 355.65 PPM

THIS MEASUREMENT WAS MADE ON 14 MAY 70

OBTAINED FROM CO2 MEASUREMENT NO. 1 AND TOTAL GAS MEASUREMENT NO. 1

SUMMARY OF MANOMETRIC CO2 CONCENTRATIONS ON CYLINDER NO. 10069 RUN NO. 4

TOTAL GAS RUN NO.	CO2 RUN NO.	CONC.
1	1	355.65
1	2	355.64

NO. OF TESTED CYLINDER = 13069 RUN NO. 4 CO2 IN N2

MENISCUS CORRECTION FOR CO2 VOLUME = -0.444 MM

MENISCUS CORRECTION FOR TOTAL GAS VOLUME = 0.000 MM

MERCURY COLUMN HEIGHTS FOR CO2 VOLUME WERE 646.910 MM AND 370.969 MM--TEMPERATURE WAS 20.05 DEG. C
MERCURY DENSITY WAS 13.5457 G/CC

MERCURY COLUMN HEIGHTS FOR TOTAL GAS VOLUME WERE 760.347 MM AND 173.545 MM--TEMPERATURE WAS 19.67 DEG. C
MERCURY DENSITY WAS 13.5467 G/CC

GAS DATA

CO2		TOTAL GAS	
VOLUME(CC)	3.7974	VOLUME(CC)	5014.9
TEMPERATURE(C)	20.05	TEMPERATURE(C)	19.67
PRESSURE(DYNE/SC)	.36555E+06	PRESSURE(DYNE/SC)	.77867E+06
VIRIAL(CC/MOLE)	-127.9	VIRIAL(CC/MOLE)	-6.1

GAS CONSTANT = .83144E+08 ERG/MOLE-DEGREE
ACCELERATION OF GRAVITY = 979.558 CM/SEC**2

*** CO2 CONCENTRATION OF THIS GAS IS 355.64 PPM

CO2 MEASUREMENT -- RERUN AFTER TRANSFER OF SAMPLE OUT OF MANOMETER THEN BACK INTO MANOMETER
(1 MINUTE TRANSFER TIMES)

THIS MEASUREMENT WAS MADE ON 14 MAY 70

OBTAINED FROM CO2 MEASUREMENT NO. 2 AND TOTAL GAS MEASUREMENT NO. 1

Appendix 5. Summary of Results

Results of the 1969-70 manometric reference gas calibrations as calculated by the current method first used in 1972 are summarized in Appendix 4. Twenty-two runs on four reference gases were made. The first runs and reruns are summarized and averaged separately. On the average the reruns are .06 ppm or about .02% lower than the first runs, perhaps due to loss of CO_2 during the transfers out of and back into the small manometer. The average adjusted indices in the last column are obtained from the average indices in Appendix 3 by the following calibration equation determined in 1959:

$$\text{Adjusted Index} = 1.2186(\text{Index})-68.096$$

Appendix 5. Summary of Results

Cylinder No.	Run No.	Individual Determination (ppm) 1st Run	Individual Determination (ppm) Rerun	Average (ppm) 1st Run	Average (ppm) Rerun	Average Adjusted Index* (ppm)
7366	1	276.48	276.35	276.57	276.51	275.94**
	2	276.60	276.61	(σ = .08	.14	
	3	276.63	276.56			
6078	6	310.86	310.90	310.95	310.89	311.50
	7	311.01	311.09	(σ = .17	.20)	
	8	310.62	310.53			
	9	311.00	310.86			
	10	310.93	310.80			
	11	311.07	310.95			
	12	311.14	311.11			
2399	1	324.12	323.84	324.19	324.12	324.61
	2	324.57	324.43	(σ = .22	.22)	
	3	323.99	324.03			
	4	324.46	324.42			
	5	324.10	324.01			
	6	324.09	324.07			
	7	324.19	324.22			
	8	323.98	323.90			
10069	1	355.71	355.54	355.64	355.60	354.47
	2	355.74	355.63	(σ = .12	.05)	
	3	355.46	355.57			
	4	355.65	355.64			

*From Reference Gas Report 17 (Appendix 3).

**Derived from high span calibrations only.