RESEARCH REPORT NO. 1
October 15, 1958
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A Summary of Reference Gas Analyses with Applied Physics Corporation Infrared Gas Analysers Nos. 46 and 55 March 30, 1957 to July 23, 1958

I. Introduction

This report presents a summary of measurements of the concentration of carbon dioxide gas in specially prepared mixtures of carbon dioxide in nitrogen gas. The measurements were obtained with the aid of continuous-flow infrared gas analysers manufactured by the Applied Physics Corporation of Pasadena, California. The mixtures were prepared by introducing dried water-pumped nitrogen into high pressure steel tanks together with enough carbon dioxide gas to give a final concentration of carbon dioxide approximately equal to normal air. Each filled tank contained approximately 220 cubic feet of gas (s.t.p.) compressed to approximately 2200 p.s.i. The mixtures were prepared as a means of referring gas analyser measurements of the concentration of carbon dioxide in air to standard gases of fixed composition. In order to obtain a measurement of concentration using the gas analyser as the analytical tool, gas from a tank after passing through a pressure regulator and reducer was caused to flow through the cell of the gas analyser at a rate normally regulated at 0.5 liters per minute. The gas pressure in the cell was held at nearly the ambient pressure by allowing the gas to discharge from the cell directly to the room. On an electronic recorder connected with the analyser, a pen trace was obtained which could be related to concentration of carbon dioxide in the flowing sample of gas by a known calibration curve. In the comparatively narrow range of concentration found for the mixtures, direct scale readings and concentration of carbon dioxide were nearly directly proportional. In the following text the mixtures will generally be referred to as reference gases.

In this report are assembled the observed differences in scale readings for such reference gases analysed between March 31, 1957 and July 23, 1958. From the average differences for individual pairs of gases, index values are computed which relate observed differences, corrected for changes in calibration of the analyser, to the difference observed for a particular pair of standard gases used to define the magnitude and range of the index. The index values approximate true concentrations in parts of carbon dioxide per million parts of air, but assume a linear relationship between index and scale readings of the recorder.

The calculation of index values is regarded as the first step in determining correct concentration values. Upon completion of a manometer and gas handling system capable of making accurate direct determinations of the concentration of carbon dioxide in air and nitrogen, the concentration of the two standard gases will be determined accurately and a series of mixtures covering the full range of index values encountered in this report will be analysed both by the gas analyser and by the manometor in order to obtain an accurate relationship between index values and concentration.

II. Analyses from May 25, 1957 to July 23, 1958

A. Indices for Primary Standards

On May 25, 1957 tanks C-7 and C-5 were set aside as primary reference gas standards with assigned indices of 320.00 and 338.00 p.p.m. (parts per million), respectively. The assignments of these index values were determined as follows: what appeared to be the most representative readings of carbon dioxide in air at Scripps during March and April, 1957 were assumed to have an average concentration of 314 p.p.m., corresponding to the average found by Keeling (Private Communication) during 1955 and 1956

for air near the Pacific Coast of North America. The recorder was calibrated approximately by running pure nitrogen (zero carbon dioxide concentration) versus tanks with a concentration near that of air. With this calibration the gas in tank C-7 was found to contain approximately 6 p.p.m. more carbon dioxide than air. For convenience in working up data, it was assigned an index of exactly 320.00 p.p.m. The gases in tanks C-7 and C-5 were then run versus nitrogen and the concentration in tank C-5 was calculated, assuming concentrations of 0 and 320.00 p.p.m. for nitrogen and tank C-7 respectively. Account was taken of the nonlinearity in the relationship between concentration and recorder scale using the calibration curve furnished by the Applied Physics Corporation (Technical Manual, graph following page 3 of section II). The gas in tank C-5 was found to have a value of 337.8. It was assigned an index of exactly 338.00 p.p.m., again for convenience. It is believed that the assigned indices for C-5 and C-7 correspond to correct concentrations within ± 5p.p.m.; the difference in index between tanks to within 5% of the correct difference in concentration.

Since these assignments were made, the plan, in principle, has been to compare the recorder traces of all other reference gases with the traces obtained from the primary standards. It has been necessary in practice, however, to adopt two additional reference gas standards in order to conserve the contents of tanks C-5 and C-7 and to have a basis for maintaining the index if a primary standard were accidently lost. The index values of the two additional standards were determined by direct comparison with tanks C-5 and C-7, and then the working reference gases used for routine comparisons with air were compared with the additional standards. During the period covered by this report the basic plan has not always been followed, and it has been found necessary in this report to establish

the indices of several more reference gases (referred to as substandards) before determining the indices of the working reference gases.

B. Summary of Analyses. Tables 1 and 2.

In Table 1 are assembled the data for all reference gases analysed with Analyser No. 46. Similar data pertaining to Analyser No. 55 are assembled in Table 2. The entries in columns 1, 2, 3, 4 and 9 are taken directly from Research Notebook VII. Page references in column 8 are to this notebook unless otherwise noted. Entries in columns 5, 6, and 7 are quantities calculated with the aid of Tables 3 through 11. Their derivation will be explained in a later section of this report.

C. Indices for Additional Reference Gas Standards. Table 3.

On December 5, 1957 the gases in tanks 4283 and 4296 were set aside as additional standards. In Table 3 contemporaneous comparisons involving these tanks and tanks C-5 and C-7 are arranged in chronological order. Index values for tanks 4283 and 4296 are obtained by direct comparison of scale differences between pairs of tanks. Final weighted average values of the index difference between tank C-5 and tank 4283, based on 62 individual comparisons is found to be -26.52. The index value for the gas in tank 4283 is therefore:

$$338.00 - 26.52 = 311.48 \text{ p.p.m.}$$

The final weighted average difference between tank 4283 and tank 4296, based on 63 individual comparisons, is found to be -18.80. The index value for the gas in tank 4296 is therefore:

$$311.48 - 18.80 = 292.28 \text{ p.p.m.}$$

D. Recorder Scale Factor. Table 4.

The relationship between index values and recorder scale readings for various dates in the interval covered by this report has been determined

from the existing comparisons of reference gas standards C-7, C-5, 4283, and 4296. The original scale differences taken from Tables 1 and 2 and the factors computed from these differences appear in Table 4 in chronological order for each analyser separately. The recorder scale factor which appears in this table is defined as the equivalent value for the scale difference between C-5 and C-7 based on the comparison between a pair of reference gases for which the index difference is already assigned or computed. The factor is computed from the observed scale difference by multiplying that difference by the quotient, index difference for C-5 versus C-7 divided by index difference for the pair of reference gases in question. For example, on December 4, 1957 the scale difference, 4283 versus 4296, is reported to be 18.69. The recorder scale factor computed from this value is therefore:

$$18.69 \times 18.00/18.80 = 17.89$$

The quotient obtained by dividing the recorder scale factor by 18.00 yields the ratio, scale difference to index difference.

The span control of the recorder which governs the response of the recorder to changes in signal from the analyser was usually set so that the pen of the recorder would move approximately 1 scale division (1 ordinate) for a change of 1 p.p.m. in the index. It was usually left at the same setting for an extended period in order that changes in scale factor would reflect directly changes in the sensitivity of the analyser.

E. Indices for Reference Gas Substandards. Table 5.

In order to obtain a chronology of recorder sensitivity more complete than is available from the recorder scale factors assembled in Table 4, it is necessary to make use of existing comparisons of other reference gases for which enough data exist to establish reliable index values.

Gases in tanks B-3, C-8, 3751, 3758, and 4277 fall into this category and have been designated substandards. (For completeness, data for the gas in tank C-1 is also included although this tank was used only before March 31, 1957.) Computed index values for these tanks are presented in Table 5. Recorder scale factors from Table 4 are used to convert observed scale differences to differences in index. The only comparisons chosen for inclusion in Table 5 are those which were made within a few days of the comparison of reference gas standards used to compute the recorder scale factors of Table 4. Because some of these gases were not always systematically compared with the proper standards the assembled comparisons in some instances form a rather complicated set. For tank 3758 numerous comparisons of working reference gases with this tank and with tank 4283 are included in the tabulation because they furnish substantial additional data for determining the index difference between tanks 3758 and 4283.

F. Additional Recorder Scale Factors. Table 6.

Recorder scale factors based on the comparisons of the substandards are assembled in Table 6 following the same arrangement used in Table 4.

G. Chronological Assignment of Recorder Scale Factors. Tables 7, 8, 9, and 10.

In Tables 7 and 8 the history of the uses of Analysers No. 46 and No. 55 are assembled. In Table 9 a summary is presented of the recorder scale factors reported in Tables 4 and 6 arranged in chronological order for each analyser separately. The dates to which particular determinations apply have been deduced from the information in Tables 7 and 8. If it is assumed that during periods of continuous measurements of air the recorder scale factor changed linearly with time between dates for which scale factors are given in Table 9, it is possible to compute daily

values of the scale factor during these periods. This has been done for Analyser No. 46 in Table 10 for the period March 31 until October 19, 1957 when the factor evidently declined steadily. For the period from October 20, 1957 until May 25, 1958 the scale factor remained nearly constant and the average value of all determinations from October 19 to November 3, 1957 is assigned for the period October 19 until December 23, 1957 (the period of Downwind Expedition), the average value determined on April 5, 1958 for the period April 5 until May 25, 1958. Similarly, the average value of the determinations on July 2 and 9 is assigned for the period June 12 to July 23, 1958.

During the period of this report, Analyser No. 55 was used only intermittently. Because of numerous changes in the optical properties of this instrument the scale factor is uncertain except on the exact dates when it was determined.

H. Indices for Working Reference Gas Mixtures and Additional Substandards. Table 11.

Before the indices for the working reference gases listed in Tables 1 and 2 can be determined, it is necessary to establish indices for all reference gases to which these were compared. In all but one instance the latter were standards or substandards for which indices are quoted in Tables 3 or 5. The index for tank 3758 could not be included in Table 5 because it depended on an interpolated scale factor. Its index is computed in a separate table of additional substandards (Table 11).

I. Index Values of Working Gases. Table 12.

The computed values of the indices of the working reference gases are listed in Tables 1 and 2 where the original scale differences appear. In column 5 of these tables are listed recorder scale factors which, according to Tables 9 or 10, apply to the dates when the scale differences in

column 3 were observed. Index differences based on these factors appear in column 6, index values of the working reference gases in column 7. The latter values are computed as the sum of the index for the standard or substandard listed in column 1 and the index difference listed in column 6. They refer only to the analyses in question and do not in all cases represent final values.

In Table 12 the index values from Tables 1 and 2 are assembled for each reference gas and final index values computed. These are averages which except as noted below give equal weight to all the existing data. The table has been separated into lettered subsections according to the use of the gas.

III. Analyses prior to May 25, 1957.

Before May 25, 1957 when tanks C-5 and C-7 were set aside as primary reference gas standards several reference gases were compared with one another and with C-5 and C-7 without much regard for system. The index differences for these gases will be deduced by the following rather complicated assembly of data:

Key to Early Tank Numbering System

A-1	2406
A-2	2419
A-3	2407
A-4	2400
A-5	2427
A-6	193
A-7	2401
A-8	136
A-9	1008
A-10	2403
A-11	2399
A-12	148
A-13	2408
A-14	2420
A-15	2404
A-16	2405
A-17	181
A-18	2402
A-19	132, 2424
A-20	2421
A-22	3751
A-23	3754
A-24	4271
A-25	4273
A-26	4276
A-27	4278
A-28	4283
A-29	4289
A-30	4290
A-31	6052
A-32	6060
A-33	6073
A-34	6078
C-5	164
C-7	221
C-8	1004

A. Analyses of Tank B-3

		Scale Difference		Span Factor	ppm Difference	
	March 30, span 500					
(221)	C-7 vs. B-3:	46.15	(4)	x 18.00/37.0 =	22.45	(2)
(164)	C-5 vs. B-3:	9.2	(2)			
	C-7 vs. C-5:	(Calculated from the above):				
		37.0	(2)	(This value is used as the denominator of the span factor, above)		
	April 28, span 500					
	C-7 vs. C-5:	35.3	(2)			
	C-7 vs. B-3:	43.35	(4)	x 18.00/35.3 =	22.10	(2)
	April 28, span 235					
	C-7 vs. C-5:	18.0	(2)			
	C-7 vs. B-3:	22.4	(2)	x 18.00/18.0 =	22.40	(2)
	Final wt'd average for C-7 vs. B-3:				22.32	(6)

The analyses which follow will be computed using this assignment for C-7 vs. B-3.

B. Analyses of Tanks B-4, B-5 and B-7

	March 30, span 500					
	C-7 vs. B-3:	46.15	(4)			
	B-3 vs. B-4:	0.4	(2)	x 22.32/46.15 =	0.19	(2)
	B-3 vs. B-5:	-53.15	(4)	x 22.32/46.15 =	-25.70	(4)
	C-7 vs. B-4:	(calculated from the above, ppm.)				
		0.19 + 22.32 =			22.51	(2)
	C-7 vs. B-5:	(calculated from the above, ppm):				
		-25.70 + 22.32 =			-3.38	(4)

	Scale Difference		Span Factor	ppm Difference	
April 10-11, span 500					
B-3 vs. B-7:	0.8	(8)	x 22.32/45.33 =	0.39	(8)
C-7 vs. B-7:	46.05	(4)			
C-7 vs. B-3:	(calculated from the above):				
	46.05 - 0.8 =	45.25	(4)		
C-7 vs. B-3:		45.5	(2)		
C-7 vs. B-3, wt'd av.:	45.33	(6)	(This value is used as the denominator of the span factor, above)		
C-7 vs. B-7	(Calculated from the above, ppm):				
	0.39 + 22.32 =			22.71	(8)
March 31, span 210					
C-7 vs. B-3:	21.8	(2)			
April 2-7, span 210					
C-7 vs. B-4:	21.7	(6)	x 22.32/22.8 =	22.22	(4)
April 10, span 210					
C-7 vs. B-3:	21.8	(2)			
April 13, span 210					
C-7 vs. B-7:	22.1	(2)	x 22.32/21.8 =	22.63	(2)

Final wt'd average for C-7 vs. B-4:

March 30, span 500	22.51	(2)
April 2-7, span 210	22.22	(4)
wt d av.:	22.32	(6)

Final wt'd av. for C-7 vs. B-5:

March 30, span 500:	-3.38	(4)

Final wt'd average for C-7 vs. B-7:

April 10-11, span 500:	22.71	(8)
April 13, span 210:	22.63	(2)
wt'd av.:	22.69	(10)

The final weighted averages for tanks B-3, B-4, B-5 and B-7 versus tank C-7 are entered in column 6 of Table 1 and used to compute indices for these working reference gases.

Table 1. Reference Gas Comparisons with Analyser No. 46

Col: 1 (Sub) Standard Tank No.	2 Compared Tank No.	3 Observed Scale Difference	4 No. of Comparisons	5 Recorder Scale Factor	6 Computed Index Difference	7 Computed Index	8 Table and Sheet No.		9 Date of Analysis
Span 235									1957
C-7	B-3	See Text	6	---	22.32	342.32	12A	2-6	Mar. 30 - Apr. 28
C-7	B-4	See Text	6	---	22.32	342.32	12A	2-6	Mar. 30 - Apr. 7
C-7	B-5	See Text	4	---	- 3.38	316.62	12B	2-6	Mar. 30
C-7	B-7	See Text	10	---	22.69	342.69	12A	2-6	Apr. 10-13
C-7	3756	6.43	6	18.00	6.43	326.43	12A	6	May 4-11
C-7	3754	8.19	9	18.00	8.19	328.19	12A	6	May 14-24
C-7	C-5	18.04	7	---	---	---	4A	9	May 22-24
C-7	3753	6.04	7	17.91	6.07	326.07	12A	10	Jun. 3
C-7	3759	17.00	7	17.81	17.18	337.18	12A	10	Jun. 11
C-7	3758	9.00	8	17.66	9.17	---	11	10	Jun. 24
Span 235:	Mukluk	Expedition	(Jul. 22 - Aug. 22)						
3758	3757	0.73	7	17.44	0.75	329.69	12A	85*	Jul. 22
3758	3752	0.85	4	17.36	0.88	329.82	12A	85*	Jul. 29
3758	3755	7.77	25	17.10	8.18	337.12	12A	85*	Aug. 21-22
C-7	C-5	17.06	30	---	---	---	4A	15	Aug. 29 - Sept. 6
C-5	3758	- 8.70	19	17.06	- 9.18	---	11	15	Aug. 29-30
3758	3751	4.94	5	17.04	5.22	334.16	12A	16	Aug. 30
C-7	3751	13.41	9	16.93	14.26	334.26	12A	16	Sept. 6
C-5	3760	- 8.22	17	16.72	- 8.85	329.15	12A	18	Sept. 13-20
C-5	4295	-37.53	29	16.57	-40.77	297.23	12A	19	Sept. 22-29
C-5	4292	-40.50	28	16.50	-44.18	293.82	12A	18a	Sept. 29-30
C-5	4296	-42.65	2	---	---	---	6	19	Sept. 16
C-5	4287	-41.30	2	---	---	---	6	19	Sept. 16
C-5	4277	-26.93	18	---	---	---	6	18	Oct. 6-11

* Data in Shipboard Ledger.

Table 1. Reference Gas Comparisons with Analyser No. 46

Col: 1 (Sub) Standard Tank No.	2 Compared Tank No.	3 Observed Scale Difference	4 No. of Comparisons	5 Recorder Scale Factor	6 Computed Index Difference	7 Computed Index	8 Table and Sheet No.	9 Date of Analysis
Span 310								1957
C-7	C-5	18.24	9	---	---	---	4A 20	Oct. 19
C-5	3760	-36.01	11	---	---	---	5 20	Oct. 19
3760	C-8	67.00	12	---	---	---	6 20	Oct. 19
Span 310	Downwind	Expedition	(Oct. 22 - Dec. 20)					
3760	3759	2.40	23(12)*	18.16	2.38	304.84	12A 104	Oct. 22
3758	C-8 (1004)	55.74	7	---	---	---	6 119	Oct. 29
3759	C-8	65.10	2	---	---	Omitted	--- 119	Oct. 29
3758	3759	- 9.80	4	18.16	- 9.71	304.07	12A 123	Oct. 31
3758	3757	- 8.68	8	18.16	- 8.60	305.18	12A 123	Oct. 31
3758	C-8	56.92	5	---	---	---	6 128	Nov. 3
3758	3757	- 7.28	8	18.16	- 7.22	306.56	12A 146	Nov. 12
3758	3757	- 7.40	3	18.16	- 7.33	306.45	12A 177	Nov. 30
3758	3756	- 8.83	5	18.16	- 8.69	305.09	12A 177	Nov. 30
3758	3756	- 9.10	7	18.16	- 9.02	304.76	12A 211	Dec. 17-20
3758	3755	-15.97	10	18.16	-15.82	297.96	12A 211	Dec. 17-20
								1958
C-7	C-5	17.97	10	---	---	---	3,4A 31	Apr. 5
C-5	4283	-26.44	11	---	---	---	3,4A 31	Apr. 5
4283	4296	-18.98	20	---	---	---	3,4A 36	Apr. 8
C-5	3758	-24.47	17	---	---	---	5 37	Apr. 15-17
4283	3758	2.39	10	---	---	---	5 30	Apr. 5
3758	C-8	55.14	11	---	---	---	5 31	Apr. 5
3758	3751	- 7.38	11	---	---	---	5 35	Apr. 8
3758	3752	-10.55	11	18.06	10.51	303.27	12A 36	Apr. 8
3758	3753	- 4.61	35	18.06	4.59	309.19	12A 34	Apr. 7-15
4283	3753	- 2.22	14	18.06	2.21	309.27	12A 30	Apr. 5
3758	3754	-14.00	10	18.06	13.95	299.83	12B 34	Apr. 7

* Number in parenthesis indicates number of (fewer) analyses to establish concentration of substandard.

Table 1. Reference Gas Comparisons with Analyser No. 46

Col: 1	2	3	4	5	6	7	8	9
(Sub) Standard Tank No.	Compared Tank No.	Observed Scale Difference	No. Of Comparisons	Recorder Scale Factor	Computed Index Difference	Computed Index	Table and Sheet No.	Date of Analysis
Span 310								1958
3758	3755	-15.80	10	18.06	15.75	298.03	12A 33	Apr. 7
3758	3756	- 9.17	9	18.06	9.14	304.64	12A 34	Apr. 7
3758	3757	- 8.22	11	18.06	8.19	305.59	12A 11	Apr. 8
3758	3759	- 9.14	10	18.06	9.11	304.67	12A 35	Apr. 8
3758	3755	-16.36	6	18.06	-16.31	297.47	12A 37	Apr. 17
3758	4296	-23.14	5	---	---	---	6 42	Jun. 17
3758	2421	-17.55	10	19.66	16.09	297.69	12A 42	Jun. 17
3758	3754	-12.88	11	19.66	-11.79	301.99	12B 43	Jun. 17
3758	3760	-17.55	2	19.66	-16.07	297.71	12A 43	Jun. 17
3758	4292	-19.43	3	19.66	-17.79	295.99	12D 43	Jun. 17
3758	4295	-17.06	3	19.66	-15.62	298.16	12D 43	Jun. 17
3758	2418	- 4.53	16	19.66	- 4.15	309.63	12A 44	Jun. 16-17
C-7	C-5	19.64	11	---	---	---	3,4A 45	Jul. 2
C-7	C-5	19.64	10	---	---	---	3,4A 54	Jul. 9
C-5	4283	-29.09	10	---	---	---	3,4A 45	Jul. 2
C-5	4283	-28.83	10	---	---	---	3,4A 54	Jul. 9
4283	4296	-20.53	10	---	---	---	3,4A 46	Jul. 2
4283	4296	-20.61	10	---	---	---	3,4A 54	Jul. 9
4283	4296	-20.80	8	---	---	---	4A 59	Jul. 11
4283	4296	-20.13	10	---	---	---	4A 57	Jul. 14
C-5	4296	-49.65	10	---	---	---	3 46	Jul. 2
C-5	3758	-26.49	10	---	---	---	5 44	Jul. 2
C-5	3758	-26.36	10	---	---	---	5 55	Jul. 9
4283	3758	2.49	10	---	---	---	5 55	Jul. 9
C-5	C-1	-48.07	10	---	---	---	5 56	Jul. 9
C-7	C-1	-28.47	10	---	---	---	5 56	Jul. 9
C-5	C-8	34.39	10	---	---	---	5 45	Jul. 2
C-5	C-8	34.29	10	---	---	---	5 55	Jul. 9
4283	4277	- 3.41	10	---	---	---	5 53	Jul. 8
4283	3751	- 5.58	9	---	---	---	5 59	Jul. 11
4283	3751	- 5.19	10	---	---	---	5 57	Jul. 14

Table 1. Reference Gas Comparisons with Analyser No. 46

Col: 1	2	3	4	5	6	7	8	9
(Sub) Standard Tank No.	Compared Tank No.	Observed Scale Difference	No. of Compari-sons	Recorder Scale Factor	Computed Index Difference	Computed Index	Table and Sheet No.	Date of Analysis
Span 310:								1958
4283	3752	- 8.86	10	19.66	- 8.11	303.37	12A 52	Jul. 8
3758	3753	- 5.04	10	19.66	- 4.61	309.17	12A 44	Jul. 2
4283	3755	-14.85	10	19.66	-13.60	297.88	12A 52	Jul. 8
4283	3756	- 7.48	10	19.66	- 6.85	304.63	12A 52	Jul. 8
4283	3757	- 6.29	10	19.66	- 5.76	305.72	12A 53	Jul. 8
4283	3759	- 7.30	10	19.66	- 6.68	304.80	12A 53	Jul. 8
3758	3754	-12.70	10	19.66	-11.63	302.15	12B 46	Jul. 2
3758	3760	-17.32	10	19.66	-15.86	297.92	12A 47	Jul. 2
3758	4292	-19.32	10	19.66	-17.69	296.09	12D 47	Jul. 2
3758	4295	-17.16	9	19.66	-15.71	298.07	12D 47	Jul. 2
4283	2421	14.49	10	19.66	13.27	298.21	12A 49	Jul. 7
3758	2421	17.06	5	19.66	15.62	298.16	12A 59	Jul. 11
4283	A-8 (136)	9.01	10	19.66	8.25	319.73	12C 48	Jul. 3
4283	A-9 (1008)	67.88	10	19.66	62.15	373.63	12C 51	Jul. 7
4283	A-10 (2403)	- 0.70	10	19.66	- 0.64	310.84	12C 48	Jul. 3
3758	A-10	- 3.27	10	19.66	- 2.99	310.79	12C 56	Jul. 9
3758	A-10	- 3.05	10	19.66	- 2.79	310.99	12C 57	Jul. 14
4283	A-11 (2399)	- 1.33	10	19.66	- 1.22	310.26	12C 48	Jul. 3
3758	A-11	- 3.93	4	19.66	- 3.60	310.18	12C 56	Jul. 9
4283	A-12 (148)	27.36	10	19.66	25.05	336.53	12C 49	Jul. 3
4283	A-13 (2408)	10.49	10	19.66	9.60	321.08	12C 49	Jul. 3
4283	A-14 (2430)	28.09	10	19.66	25.72	337.20	12C 50	Jul. 7
4283	A-15 (2404)	5.54	10	19.66	5.07	316.55	12C 50	Jul. 7
4283	A-16 (2405)	25.78	10	19.66	23.60	335.08	12C 50	Jul. 7
4283	A-17 (181)	21.91	10	19.66	20.06	331.54	12C 51	Jul. 7
4283	A-18 (2402)	9.96	10	19.66	9.12	320.60	12C 51	Jul. 7

Table 2. Reference Gas Comparisons with Analyser No. 55

Col: 1	2	3	4	5	6	7	8	9
(Sub) Standard Tank No.	Compared Tank No.	Observed Scale Difference	No. of Compari-sons	Recorder Scale Factor	Computed Index Difference	Computed Index	Table and Sheet No.	Date of Analysis
Span 275								1957
C-7	C-5	17.80	20	---	---	---	4B 23	Dec. 4
C-5	4283	-26.48	10	---	---	---	4B 23	Dec. 4
4283	4296	-18.69	10	---	---	---	4B 23	Dec. 4
4283	2421	- 5.02	10	17.86	- 5.06	See footnote.	--- 23	Dec. 4
C-7	C-5	---	40	---	18.00*	---	3 23	Dec. 4
C-5	4283	---	20	---	-26.66*	---	3 23	Dec. 4
4283	4296	---	20	---	-18.71*	---	3 23	Dec. 4
4283	2421	---	20	---	- 5.06*	306.42	12B 23	Dec. 4
4283	4296	-16.57	10	---	---	---	4B 22A	Dec. 16
4283	2418	- 3.86	11	15.86	- 4.38	307.10	12A 22A	Dec. 16
4283	2421	- 4.60	3	15.86	- 5.22	306.26	12B 22	Dec. 18
Span 380								1958
4283	4296	-19.43	21	---	---	---	3,4B 24	Jan. 9
4283	4284	- 2.77	12	---	---	---	5 24	Jan. 9
4284	4287	-15.51	14	---	---	---	5 24	Jan. 9
4284	2423	- 2.30	2	18.61	- 2.22	306.58	12D 24	Jan. 9
4284	2425	- 2.20	2	18.61	- 2.13	306.67	12D 24	Jan. 9
4284	2426	- 2.55	2	18.61	- 2.47	306.33	12D 24	Jan. 9
4283	4277	- 3.30	5	---	---	---	5 26	Jan. 10
C-5	4277	-30.78	5	---	---	---	5 26	Jan. 10
C-7	C-5	18.70	13	---	---	---	3,4B 26	Jan. 10
C-5	4283	-27.33	12	---	---	---	3,4B 26	Jan. 10
Span 275								
4283	4296	16.55	10	---	---	---	4B 28	Jan. 23
4283	2421	- 4.54	5	15.84	- 5.16	306.32	12B 28	Jan. 23
4277	2421	- 1.61	9	15.84	- 1.83	306.50	12B 28	Feb. 6
4283	2421	- 4.43	6	15.84	- 5.03	306.45	12B 28	Feb. 6
C-8	3751	59.88	4	---	---	---	6B 40	May 3

* Index values computed directly in notebook, p. 23 on account of joint comparison with analyser No. 58.

Table 3. Index Values of Reference Gas Standards

Col: 1	2	3	4	5	6	7	8	9
Analyser	(Sub) Standard Tank No.	Compared Tank No.	Observed Scale Difference	No. of Compari-sons	Recorder Scale Factor	Computed Index Difference	Computed Index	Table and Sheet No.	Date of Analysis
									1957
55 + 58	C-7	C-5	18.00	40	18.00	---	---		Dec. 4
	C-5	4283	-26.66	20	---	-26.66			
	4283	4296	-18.71	20		-18.71			
									1958
55	C-7	C-5	18.70	13	18.70	---	---		Jan. 10
	C-5	4283	-27.33	12		-26.31			Jan. 10
	4283	4296	-19.43	21		-18.70			Jan. 9
46	C-7	C-5	17.97	10	17.97	---	---		Apr. 5
	C-5	4283	-26.44	11		-26.48			
	4283	4296	-18.98	20		-19.01			
46	C-7	C-5	19.64	11	19.64	---	---		Jul. 2
	C-5	4283	-29.09	10		-26.66			
	4283	4296	-20.53	10		-18.82			
	C-5	4296	-49.65	10		-45.50			
46	C-7	C-5	19.64	10	19.64	---	---		Jul. 9
	C-5	4283	-28.83	10		-26.42			
	4283	4296	-20.61	10		-18.89			

Weighted Average Index Differences:
C-5 versus 4283 = 63 comparisons -26.52 p.p.m.
4283 versus 4296 = 63 comparisons -18.80 p.p.m. (81) 18.82
C-5 versus 4296 = Not used.

Concentration of Tanks 4283: 338.00 - 26.52 = 311.48 p.p.m.
Concentration of Tanks 4296: 311.48 - 18.80 = 292.68 p.p.m.

Table 4A. Recorder Scale Factors Based on Comparisons of Standards with Analyser No. 46.

Col: 1	2	3	4	5	6	7		8
Span Setting	Standard Tank No.	Compared Tank No.	Observed Scale Difference	No. of Comparisons	Index Difference	Recorder Scale Factor Single Set	Recorder Scale Factor Wt'd Average	Date of Analysis
								1957
235	C-7	C-5	18.04	7	18.00		18.04	May 22
235	C-7	C-5	17.06	30	18.00		17.06	Aug. 30
310	C-7	C-5	18.24	9	18.00		18.24	Oct. 19
								1958
310	C-7	C-5	17.97	10	18.00	17.97		Apr. 5
310	C-5	4283	-26.44	11	-26.52	17.95		Apr. 5
310	4283	4296	-18.98	20	-18.80	18.16		Apr. 5
				41			18.06	
310	C-5	C-7	19.64	11	18.00	19.64		Jul. 2
310	C-5	C-7	19.64	10	18.00	19.64		Jul. 9
310	C-5	4283	-29.09	10	-26.52	19.74		Jul. 2
310	C-5	4283	-28.83	10	-26.52	19.57		Jul. 9
310	4283	4296	-20.53	10	-18.80	19.66		Jul. 2
310	4283	4296	-20.61	10	-18.80	19.73		Jul. 9
310	4283	4296	-20.80	8	-18.80	19.92 *		Jul. 11
310	4283	4296	-20.13	10	-18.80	19.27 *		Jul. 14
				61			19.66	

*Omitted from average by oversight

Table 4B. Recorder Scale Factors Based on Comparisons of Standards with Analyser No. 55.

Col: 1	2	3	4	5	6	7		8
						Recorder Scale Factor		
Span Setting --	Standard Tank No.	Compared Tank No.	Observed Scale Difference	No. of Comparisons	Index Difference	Single Set	Wt'd Average	Date of Analysis
								1957
275	C-7	C-5	17.80	20	18.00	17.80		Dec. 4
275	C-5	4283	-26.48	10	-26.52	17.97		Dec. 4
275	4283	4296	-18.69	10	-18.80	17.89		Dec. 4
				40			17.86	Dec. 4
275	4283	4296	-16.57	10	-18.80		15.86	Dec.16
								1958
380	4283	4296	-19.43	21	-18.80	18.59		Jan. 9
380	C-7	C-5	18.70	13	18.00	18.70		Jan.10
380	C-5	4283	-27.33	12	-26.52	18.55		Jan.10
				46			18.61	Jan. 9-10
275	4283	4296	-16.55	10	-18.80		15.84	Jan.23

Table 5. Index Values of Reference Gas Substandards

Analyser No.	Span Setting	Standard Tank No.	Sub Standard Tank No.	Observed Scale Difference	No. or Comparisons	Recorder Scale Factor Computed in Table 4	Computed Index Difference	Computed Index	Date of Analysis
									1958
46	310	4283	3758	2.39	10	18.06	2.38		Apr. 5
46	310	4283	3758	2.49	10	19.66	2.28		Jul. 9
				Wt. av.:	20		2.33	313.81	
46	310	C-5	3758	-24.47	17	18.06	-24.39		Apr. 15, 17
		C-5	3758	-26.49	10	19.66	-24.25		Jul. 2
		C-5	3758	-26.36	10	19.66	-24.13		Jul. 9
				Wt. av.:	37		-24.28	313.72	

Values of 4283 vs. 3758 based on analyses of working tanks:

							Computed Index Difference 4283 vs. 3758		No. of Comparisons	
46	310	3758	3751	-7.38	11	18.06	-7.36			Apr. 8
		4283	3751	-5.58	9	19.66	-5.11	2.25	9	Jul. 11
		3758	3752	-10.55	11	18.06	-10.51			Apr. 8
		4283	3752	-8.86	10	19.66	-8.11	2.40	10	Jul. 8
		3758	3755	-15.80	10	18.06	-15.75			Apr. 7
		4283	3755	-14.85	10	19.66	-13.60	2.15	10	Jul. 8
		3758	3756	-9.17	9	18.06	-9.14			Apr. 7
		4283	3756	-7.48	10	19.66	-6.85	2.29	9	Jul. 8
		3758	3757	-8.22	11	18.06	-8.19			Apr. 8
		4283	3757	-6.29	10	19.66	-5.76	2.43	10	Jul. 8
		3758	3759	-9.14	10	18.06	-9.11			Apr. 8
		4283	3759	-7.30	10	19.66	-6.68	2.43	10	Jul. 8
46	310	3758	A-10	-3.27	10	19.66	-2.99			Jul. 9
		4283	A-10	-0.70	10	19.66	-0.64	2.35	10	Jul. 3
		3758	A-11	-3.93	4	19.66	-3.60			Jul. 9
		4283	A-11	-1.33	10	19.66	-1.22	2.38	4	Jul. 3
		3758	2421	12.10	5	19.66	11.08			Jul. 11
		4283	2421	14.49	10	19.66	13.27	2.19	5	Jul. 3

Table 5. Index Values of Reference Gas Substandards

Analyser No.	Span Setting	Standard Tank No.	Sub Standard Tank No.	Observed Scale Difference	No. of Comparisons	Recorder Scale Factor Computed in Table 4	Computed Index Difference	Computed Index	Date of Analysis
									1958
				wt'd av.:	77		2.32	313.80	
Final wt'd av. for Tank 3758:					134			313.78	
46	310	C-5	C-1	-48.07	10	19.66	-44.01	293.99	Jul. 9
46	310	C-7	C-1	-28.47	10	19.66	-26.07	293.93	Jul. 9
Final wt'd av. for Tank C-1:					20			293.96	
46	310	3758	C-8	55.14	11	18.06	54.96	368.74	Apr. 5
46	310	C-5	C-8	34.39	10	19.66	31.49		Jul. 2
46	310	C-5	C-8	34.29	10	19.66	31.39		Jul. 9
				wt'd av.:	20		31.44	369.44	(Jul. 6)
Final wt'd av. for Tank C-8:					31			369.19	
55	380	4283	4277	- 3.30	5	18.61	- 3.19		Jan. 9-10
46	310	4283	4277	- 3.41	10	19.66	- 3.12		Jul. 2-9
				wt'd av.:	15		- 3.14	308.34	
55	380	C-5	4277	-30.78	5	18.61	-29.71	308.29	Jan. 9-10
Final wt'd av. for Tank 4277:					20			308.33	
55	380	4283	4284	(-) 2.77	12	18.61	- 2.68	308.80	Jan. 9
55	380	4284	4287	-15.51	14	18.61	-15.00	293.80	Jan. 9
46	310	3758	3751	- 7.38	11	18.06	- 7.36	306.42	Apr. 8
46	310	4283	3751	- 5.58	9	19.66	- 5.11	306.37	Jul. 11
46	310	4283	3751	- 5.19	10	19.66	- 4.75	306.73	Jul. 14
Final wt'd av. for Tank 3751:					30			306.51	
									1957
46	310	C-5	3760	-36.01	11	18.24	-35.54	302.46	Oct. 19

Table 6. Recorder Scale Factors Based on Comparison of Substandards

Analyser No.	Span Setting	Standard Tank No.	Compared Tank No.	Observed Scale Difference	No. of Comparisons	Index Difference (see note a)	Recorder Scale Factor		Date of Analysis
							Single Set	Wt'd. Average	
									1957
46	235	C-7	C-5	Note b		2		19.08	Mar. 30
46	235	C-7	C-5	Note b		2		18.00	Apr. 28
46	235	C-7	C-5	Note b		2		19.08	Mar. 30
46	235	C-5	4296	-42.65	2	45.32	16.94		Sept. 16
46	235	C-5	4287	-41.30	2	44.20	16.82	16.88	Sept. 16
46	235	C-5	4277	-26.93	18	29.67		16.34	Oct. 6-11
46	310	3760	C-8	67.00	12	66.73	18.06		Oct. 19
46	310	58	C-8	55.74	7	55.41	18.11		Oct. 29
46	310	58	C-8	56.92	5	55.41	18.49	18.16	Nov. 3
									1958
46	310	58	4296	-23.14	5	21.10		19.74	Jun. 17
									1958
55	275	3751	C-8	59.88	4	62.68		17.20	May 3

Note a:

Calculation of Index Differences from index values in Table 5:

C-5	vs.	4296	338.00 - 292.68 =	45.32
C-5	vs.	4287	338.00 - 293.80 =	44.20
C-5	vs.	4277	338.00 - 308.33 =	29.67
3758	vs.	4296	313.78 - 292.68 =	21.10
C-8	vs.	3751	369.19 - 306.31 =	62.68
C-8	vs.	3760	369.19 - 302.46 =	66.73
C-8	vs.	3758	369.19 - 313.78 =	55.41

Table 6. Recorder Scale Factors Based on Comparisons of Substandards

Note b:

Recorder Scale Factor has been estimated from a comparison of analyses on March 30 and April 28, as follows:

	Scale Difference	Recorder Scale Factor	Index Difference
March 30, Span 500			
B-3 vs. C-7:	-46.15 (4)	(÷ 18.00)	
April 28, Span 500			
B-3 vs. C-7:	-43.35 (4)		
April 28, Span 235			
C-7 vs. C-5	-18.00 (2)		

Equivalent C-7 vs. C-5 at Span 235 on March 30:

18.00 x 46.15/43.35 = 19.16 (4)

March 30, Span 500

C-7 vs. C-5 (Calculated from difference between B-3 vs. C-7 and B-3 vs. C-5) 37.00 (2)

April 28, Span 500

C-7 vs. C-5 35.30 (2)

Equivalent C-7 vs. C-5 at Span 235 on March 30:

18.00 x 37.00/35.30 = 18.92 (2)

Final wt'd average: 19.08 (6)

(Although weighting involves six analyses, the final average is no better than the two analyses of C-7 vs. C-5 at Span 235 on April 28.)

Table 7. Analyser 46: History of Use

Dates		Use	
1957		Routine Air	Other
Mar. 21	May 27	SIO - R.H.	
May 27	May 29		Trial installation on ship
May 29	Jun. 28	SIO - R.H.	
Jul. 8	Aug. 26	Mukluk Cruise	
Aug.29	Sept. 20	SIO - R.H.	
Sept. 20	Oct. 13	SIO - Pier	
Oct. 16	Oct. 20		Precruise tests on ship
Oct. 21	Dec. 23	Downwind Cruise	
Dec. 23,1957-Apr. 3,1958			Not operated. On ship until Mar. 30
1958			
Apr. 4	Apr. 22	SIO - R.H.	
Apr. 25	May 25	SIO - R.H.	
Jun. 12	Jul. 23	SIO - R.H.	(Cell cleaned prior to Jun. 12)
Jul. 24			Intermittent use with vacuum line in R.H.

Note: R.H. = Ritter Hall, Scripps Campus
SIO = Scripps Institution of Oceanography

Table 8. Analyser 55: History of Use

Dates		Use	
1957		Routine Air	Other
Aug. 1	Aug. 14		Ref. Tank Analyses R.H.
Dec. 4	Dec. 5		Ref. Tank Analysis. Instrument calibrated
Dec. 6,1957	Jul. 24, 1958		Intermittant use with vacuum line R.H.

Special dates:	Remarks
1957	
Dec. 6 - 16	Hg entered cell reducing sensitivity
Dec. 16	Instrument recalibrated
Dec. 16 - Jan. 9	More Hg entered cell reducing sensitivity further
1958	
Jan. 9	Instrument recalibrated, new span setting.
Jan. 9 - 13	More Hg entered cell
Jan. 13	Cleaned cell
Jan. 13 - 21	Cell remained clean
Jan. 21	Hg entered cell reducing sensitivity again
Jan. 23	Recalibrated
Jul. 24	SIO - Pier — Cell cleaned prior to this installation.

Table 9. Summary of Recorder Scale Factors

Span	Date	Reference to Table No.	No. of Comparisons	Recorder Scale Factor	Days to Apply
Analyser 46	1957				1957
235	Mar. 31	6	6	19.08	Continuous change assumed in Table 10 Mar. 31 - Oct. 13
235	Apr. 28	4	2	18.00	
235	May 22	4	7	18.04	
235	Aug. 30	4	30	17.06	
235	Sept. 16	6	4	(16.88)	Not used in Table 10
235	Oct. 6-11	6	18	16.34	
310	Oct. 19	4	9	18.24	Oct. 19
310	Oct. 19-Nov. 3	6	24	18.16	Oct. 20 - Dec. 23 (Av. used: 18.18)
	1958				1958
310	Apr. 5	4	41	18.06	Apr. 5 - May 25
310	Jun. 17	6	5	19.74	Not used in Table 10
310	Jul. 2-9	4	60	19.66	Jun. 12 - Jul. 23
Analyser 55	1957				1957
275	Dec. 4	4	40	17.86	Dec. 4 - Dec. 15
275	Dec. 16	4	10	15.86	Dec. 16, 1957 - Jan. 8, 1958
	1958				1958
380	Jan. 9	4	46	18.61	Jan. 9 - Jan. 12 Jan. 13 - Jan. 21
275	Jan. 23	4	10	15.84	Jan. 21 -
275	May 3	6	4	17.20	

Table 10. Daily Recorder Scale Factors for Analyser 46

Date	Recorder Scale Factor	Date	Recorder Scale Factor	Date	Recorder Scale Factor	Date	Recorder Scale Factor
Span 235							
1957		1957		1957		1957	
Mar. 31	19.08	May 1	18.00	Jun. 1	17.93	Jul. 1	---
Apr. 1	19.04	2	18.00	2	17.92	2	---
2	19.00	3	18.00	3	17.91	3	---
3	18.96	4	18.00	4	17.90	4	---
4	18.93	5	18.00	5	17.88	5	---
5	18.89	6	18.00	6	17.87	6	---
6	18.85	7	18.00	7	17.86	7	---
7	18.81	8	18.00	8	17.85	8	17.61
8	18.77	9	18.00	9	17.84	9	17.60
9	18.73	10	18.00	10	17.83	10	17.58
10	18.69	11	18.00	11	17.81	11	17.57
11	18.66	12	18.00	12	17.80	12	17.56
12	18.62	13	18.00	13	17.79	13	17.55
13	18.58	14	18.00	14	17.78	14	17.54
14	18.54	15	18.00	15	17.77	15	17.53
15	18.50	16	18.00	16	17.76	16	17.51
16	18.46	17	18.00	17	17.75	17	17.50
17	18.42	18	18.00	18	17.73	18	17.49
18	18.39	19	18.00	19	17.72	19	17.48
19	18.35	20	18.00	20	17.71	20	17.47
20	18.31	21	18.00	21	17.70	21	17.46
21	18.27	22	18.04	22	17.69	22	17.44
22	18.23	23	18.00	23	17.68	23	17.43
23	18.19	24	17.99	24	17.66	24	17.42
24	18.15	25	17.98	25	17.65	25	17.41
25	18.12	26	17.97	26	17.64	26	17.40
26	18.08	27	---	27	17.63	27	17.39
27	18.04	28	---	28	17.62	28	17.38
28	18.00	29	---	29	---	29	17.36
29	18.00	30	17.95	30	---	30	17.35
30	18.00	31	17.94			31	17.34

Direct determinations are underlined.

Table 10. Daily Recorder Scale Factors for Analyser 46

Date	Recorder Scale Factor	Date	Recorder Scale Factor	Date	Recorder Scale Factor	Date	Recorder Scale Factor
Span 235							
1957		1957		1957		1957	
Aug. 1	17.33	Aug. 19	17.12	Sept. 7	16.91	Sept. 25	16.57
2	17.32	20	17.11	8	16.89	26	16.55
3	17.31	21	17.10	9	16.87	27	16.54
4	17.29	22	17.09	10	16.85	28	16.52
5	17.28	23	17.08	11	16.84	29	16.50
6	17.27	24	17.07	12	16.82	30	16.48
7	17.26	25	17.06	13	16.80	Oct. 1	16.46
8	17.25	26	17.06	14	16.78	2	16.44
9	17.24	27	---	15	16.76	3	16.42
10	17.22	28	---	16	16.74	4	16.40
11	17.21	29	17.06	17	16.72	5	16.39
12	17.20	30	17.04	18	16.70	6	16.37
13	17.19	Sept. 1	17.02	19	16.69	7	16.35
14	17.18	2	17.00	20	16.67	8	16.34
15	17.17	3	16.99	21	16.65	9	16.31
16	17.16	4	16.97	22	16.63	10	16.29
17	17.14	5	16.95	23	16.61	11	16.27
18	17.13	6	16.93	24	16.59	12	16.26
						13	16.24
						14	---
						15	---

Direct determinations are underlined.

Table 11. Concentration of Additional Reference Gas Substandards

Analyser No.	Span Setting	(Sub) Standard Tank No.	Compared Tank No.	Index Difference Computed in Table 1	No. of Comparisons	Computed Index	Dates of Analysis
							1957
46	235	C-7	3758	9.17	8		Jun. 24
46	235	C-7	3751	14.26	9		Sep. 6
46	235	3751	3758	-5.22	5		Aug. 30
Calculated value:		C-7	3758	9.04	(5)		
			Wt'd av.	9.12	13	329.12	
Calculated value:		C-5	3758	-9.18	19	328.82	Aug. 29
Final wt'd av. for tank 3758:					32	328.94	

Table 12. Index Values of Working Reference Gases

Col: 1	2	3	4	5	6	7	8	9	10	11
Analyser	(Sub) Standard Tank No.	Compared Tank No.	Single Set No. of Comparisons	Index	Wt'd.Av. No. of Comparisons	Index	Compared Tank No.	Pressure (P.S.I.)	Date of Analysis	Dates of Use
A. Scripps Pier - before Mukluk Expedition									1957	1957
46	C-7	B-3			6	342.32	B-3		Mar. 30 - Apr. 28	Mar. 21-30, Apr. 24-26
46	C-7	B-4			6	342.32	B-4		Mar. 30 - Apr. 7	Mar. 30 - Apr. 9
46	C-7	B-7			10	342.69	B-7		Apr. 10-13	Apr. 9-24
46	C-7	3756			6	326.43	3756		May 4-11	Apr. 26 - May 13
46	C-7	3754			9	328.19	3754		May 14-24	May 13-27
46	C-7	3753			7	326.07	3753		June 3	May 29 - June 11
46	C-7	3759			7	337.18	3759		June 11	June 11-21
46	Various	3758			32	328.94	3758		June 24 - Aug. 29 *	June 21-28
A. Mukluk Expedition										
46	3758	3757			7	329.69	3757		Jul. 22 **	Jul. 8-24
46	3758	3752			4	329.82	3752		Jul. 29 **	Jul. 24 - Aug 16
46	3758	3755			25	337.12	3755		Aug. 21-22**	Aug. 18-30 ***

* For data see Table 11.
** Analyses made on shipboard at sea.
*** Use on pier from Aug. 29-30

Table 12. Index Values of Working Reference Gases

Col: 1	2	3	4	5	6	7	8	9	10	11
			Single	Set	Wt'd.Av.		Compared Tank			
Analyser	(Sub) Standard Tank No.	Compared Tank No.	No. of Comparisons	Index	No. of Comparisons	Index	No.	Pressure (P.S.I.)	Date of Analysis	Dates of Use
A. Scripps Pier - Between Expeditions									1957	1957
46	3758	3751	5	334.16					Aug. 30	Aug. 30 - Sep. 8
46	C-7	3751	9	334.26	14	334.22	3751		Sep. 6	
46	C-5	3760			17	329.15	3760		Sep. 13-20	Sep. 8 - 22
46	C-5	4295			29	297.23	4295		Sep. 22-29	Sep. 22-29
46	C-5	4292			28	293.82	4292		Sep. 29-30	Sep. 29 - Oct. 4
									1958	1957
46 & 55	various	4277			20	308.33	4277		Jan. 9 - July 9 *	Oct. 4-13
A. Downwind Expedition - New Fillings									1957	
46	C-5	3760			11	302.46	3760		Oct. 19 *	
A. Downwind Expedition									1957	1957
46	3758	3755			10	297.96	3755		Dec. 17-20	Dec. 19-23
46	3758	3756	5	305.09					Nov. 30	
46	3758	3756	7	304.76	12	304.90	3756		Dec. 17-20	Nov. 30 - Dec. 19
46	3758	3757	8	305.18					Oct. 31	
46	3758	3757	8	306.56**					Nov. 12	
46	3758	3757	3	306.45**	8	305.18	3757		Nov. 30	Nov. 3-30
46	3760	3759	12	304.84					Oct. 22	
46	3758	3759	4	304.07**	12	304.84	3759		Oct. 31	Oct. 21 - Nov. 3
A. Downwind Expedition - Post-cruise									1958	
46	3758	3755	10	298.03					Apr. 7	
46	3758	3755	6	297.47 **					Apr. 17	
46	4283	3755	10	297.88	20	297.96	3755		Apr. 17 Jul. 8	
46	3758	3756	9	304.64					Apr. 7	
46	4283	3756	10	304.63	19	304.63	3756		Jul. 8	
46	3758	3757	11	305.59					Apr. 8	
46	4283	3757	10	305.72	21	305.65	3757		Jul. 8	
46	3758	3759	10	304.67					Apr. 8	
46	4283	3759	10	304.80	20	304.74	3759		Jul. 8	

* For data see Table 5. ** Omitted from average.

Table 12. Index Values of Working Reference Gases

Col: 1	2	3	4	5	6	7	8	9	10	11
			Single Set		Wt'd.Av.		Compared Tank			
Analyser	(Sub) Standard Tank No.	Compared Tank No.	No. of Comparisons	Index	No. of Comparisons	Index	No.	Pressure (P.S.I.)	Date of Analysis	Dates of Use
A. Scripps Pier - After Downwind Expedition									1958	1958
46	4283	3753	14	309.27					Apr. 5	Apr. 4-16
46	3758	3753	35	309.19					Apr. 7-15	
46	3758	3753	10	309.17	59	309.21	3753		Jul. 2	
46	various	3755			20	297.96	3755		Apr. 7 - Jul. 8 *	Apr. 16-22
46	3758	3752	11	303.27					Apr. 8	
46	4283	3752	10	303.37	21	303.32	3759		Jul. 8	Apr. 25 - May 25
									1957	
55	4283	2418	11	307.10 **					Dec. 16	Jun. 13-17
									1958	
46	3758	2418	16	309.03	16	309.63	2418		Jun. 16-17	
46	3758	2421	10	297.69					Jun. 17	Jun. 18 - Jul 23
46	4283	2421	10	298 21					Jul. 3	
46	3758	2421	5	298.16	25	297.99	2421		Jul. 11	
46	3758	3760	2	297.71					Jun. 17	
46	3758	3760	10	297.92	Incomplete				Jul. 2	
B. Scripps Laboratory										
46	C-7	B-5			4	316.62	B-5		1957 Mar. 30	not used
55	4283	2421	20	306.42					Dec. 4	not used
55	4283	2421	3	306.26					Dec. 18	
									1958	
55	4283	2421	5	306.32					Jan. 23	
55	4277	2421	9	306.50					Feb. 6	
55	4283	2421	6	306.45	43	306.42	2421		Feb. 6	

* For data see Downwind - Post-cruise.
** Omitted from average.

Table 12. Index Values of Working Reference Gases

Col: 1	2	3	4	5	6	7	8	9	10	11
			Single Set		Wt'd.Av.		Compared Tank			
Analyser	(Sub) Standard Tank No.	Compared Tank No.	No. of Comparisons	Index	No. of Comparisons	Index	No.	Pressure (P.S.I.)	Date of Analysis	Dates of Use
B. Scripps Laboratory (cont)									1958	1958
46	various	3751			30	306.51	3751		Apr. 8 - Jul. 14 *	May 3, Jun. 27
46	3758	3754	10	299.83					Apr. 7	
46	3758	3754	11	301.99					Jun. 17	
46	3758	3754	10	302.15	incomplete				Jul. 2	
C. Antarctic 1st Year Returns									1958	
46	4283	A-8			10	319.73	A-8		Jul. 3	
46	4283	A-9			10	373.63	A-9		Jul. 7	
46	4283	A-10	70	310.84					Jul. 3	
46	3758	A-10	10	310.79					Jul. 9	
46	3758	A-10	10	310.99	30	310.87	A-10		Jul. 14	
46	4283	A-11	10	310.26					Jul. 3	
46	3758	A-11	4	310.18	14	310.24	A-11		Jul. 9	
46	4283	A-12			10	336.53	A-12		Jul. 3	
46	4283	A-13			10	321.08			Jul. 3	
46	4283	A-14			10	337.20	A-14		Jul. 7	
46	4283	A-15			10	316.55	A-15		Jul. 7	
46	4283	A-16			10	335.08	A-16		Jul. 7	
46	4283	A-17			10	331.54	A-17		Jul. 7	
46	4283	A-18			10	320.60	A-18		Jul. 7	
D. Mauna Loa New Fillings									1958	
55	4283	4284			12	308.80	4284		Jan. 9 *	
55	4284	4287			14	293.80	4287		Jan. 9 *	
55	4284	2423			2	306.58	2423		Jan. 9	
55	4284	2425			2	306.67	2425		Jan. 9	
55	4284	2426			2	306.33	2426		Jan. 9	
46	3758	4292	3	295.99					Jun. 17	
46	3758	4292	10	296.09	13	296.07	4292		Jul. 2	
46	3758	4295	3	298.16					Jun. 17	
46	3758	4295	9	298.07	12	298.09	4295		Jul. 2	

* For data see Table 5.

Table 13. Index Values of Standard and Substandard Tanks

Reference to Table No.	No. of Comparisons	Index	Tank No.
Text	--	320.00	C-7
Text	--	338.00	C-5
3	62	311.48	4283
3	63	292.68	4296
5	134	313.78	3758
5	20	293.96	C-1
5	31	369.19	C-8