FUEL RESEARCH INSTITUTE OF SOUTH AFRICA

TECHNICAL MEMORANDUM NO. 14 OF 1964

REPORT ON DUST COLLECTOR TESTS AT UMGENI POWER STATION, BOILER NO. 9, NOVEMBER 26TH, 1963

BY

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INTRODUCTION:

The tests reported herein were carried out on behalf of Messrs. Davidson & Co. (Africa) Ltd., the suppliers of the Dust Collector Plant, for the purpose of determining the efficiency of the installation.

A preliminary test was carried out on the dust collectors of No. 9 boiler on the 26th and 27th November, 1963. An E.C.R. and an M.C.R. test were performed. The tests were carried out during boiler trials.

PART I. DESCRIPTION OF APPARATUS AND TEST METHOD.

The operation of the dust collector was judged by weighing the total quantity of fine ashes collected by the equipment over a set period and by assessing the dust emitted from the boiler by sampling the flue gases at the dust collector outlet.

1.1 Fine Ash Collected

Determination of the quantity of fine ashes collected consisted of weighing all the dust caught by the primary and secondary collectors. To this effect temporary pipes were run from the two primary and the two secondary collector outlets (after the dust valves) to within a few feet of the floor.

The dust emitted from each of these valves was collected in dust bins, closed with a tightly fitting lid, connected by a flexible canvas sleeve to the valve outlet.

The filled bins were weighed and a sample of approximately half a pound taken from each bin.

The ashes collected at the right- and left-hand sides of the boiler were weighed at regular intervals, the results being given in Tables Nos. 1 and 2 for E.C.R. and Tables Nos. 3 and 4 for M.C.R.

1.2 Flue Dust Sampling Equipment

Flue dust sampling was carried out isokinetically and in accordance with B.S. 893 : 1940. For this purpose the sampling head illustrated in Figure 1 was used. The equipment comprises a Pitot tube, by means of which the flue gas velocity is determined, and a sampling probe through which the gas is exhausted at a velocity closely corresponding to that deduced from the Pitot tube indication. The gas then passes a miniature cyclone, in which most of the dust is precipitated, then a glass-wool filter, and finally a small shaped nozzle installed for the purpose of measuring the quantity of flue gas aspirated. For details of the construction, see Figure 2.

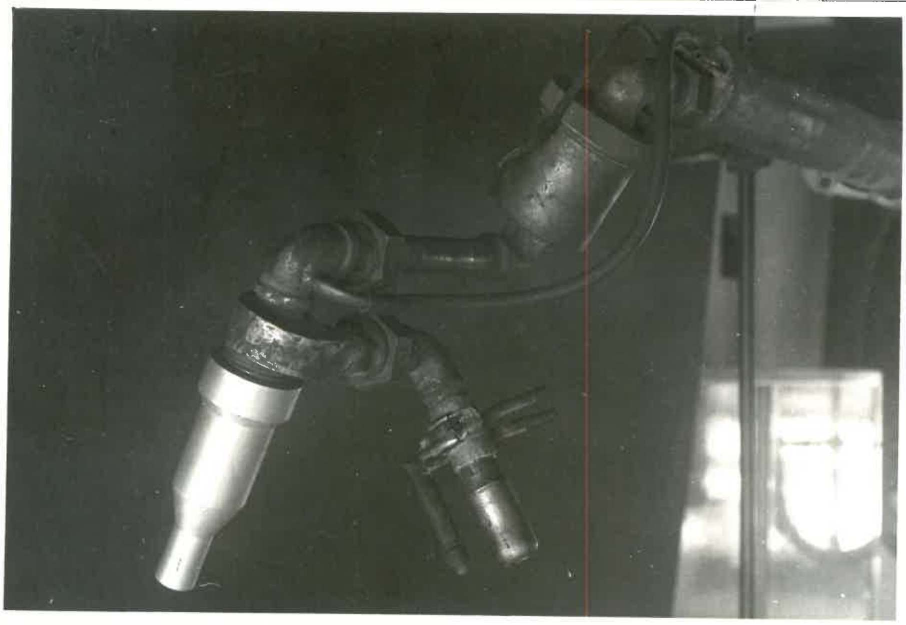


Figure I.

In addition, the sampling head contains a thermocouple by means of which the flue gas temperature may be determined.

The complete assembly is supported by a thin-walled steel tube of 2 inches diameter, through which the exhaust pipe and measuring tubes and the thermocouple wires are passed.

The equipment was designed to pass through 8" diameter sampling ports in the duct. During the test the port is closed by a heavy steel cover to which a tubular guide for the thin-walled tube is welded. A clamping device ensures that the sampling head may be rigidly fixed in any desired position.

The exhaust line, measuring tubes and thermocouple leads are extended to the measuring equipment, mounted in a case. This apparatus contains:

(a) A sliding-vane type exhauster with control valves;

(b) An inclined gauge (0 to 20 mm. by 0.2 mm. water column), connected to the Pitot tube, indicating the flue gas velocity head;

(c) A U-tube connected to pressure taps on both sides of the orifice plate; this gauge thus indicates the pressure drop across the orifice.

(d) A U-tube, connected to the Pitot static line and the atmosphere, indicating the draught or suction in the flue;

(e) An aneroid barometer and a clock;

(f) A spot-light galvanometer, connected by copper leads to two terminals embedded in an aluminium block upon which the thermocouple leads terminate.

The temperature of the block was measured by means of a mercury thermometer.

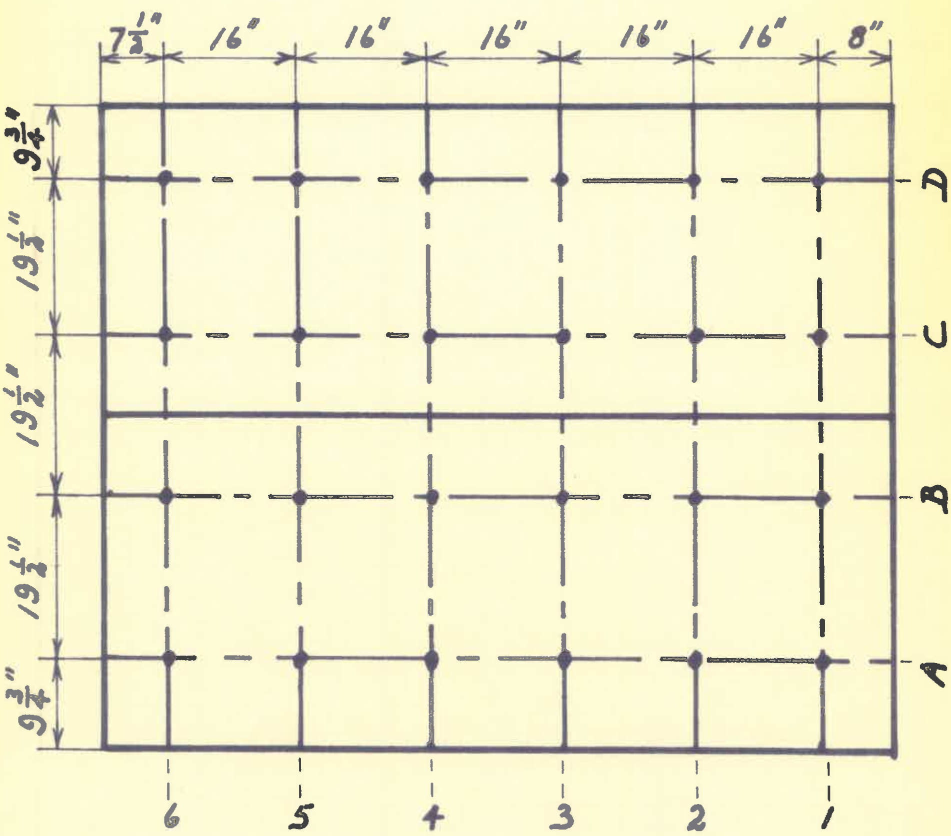
2. <u>SAMPLING PROCEDURE:</u>

In principle the test procedure is as follows: The sampling head is inserted in the duct in a suitable position, which in this test was situated before the I.D.

fan/...

UMGENI POWER STATION

BOILER No. 9



SECTION OF DUCT

FIG. 3

the particular probe, in this case ⅛", based on information collected during preliminary tests. This generally adequately covers the requirements of B.S. 893 : 1940, which allows the exhaust velocity to deviate by plus or minus 10% of the gas velocity.

Observations taken during the tests are presented in Tables Nos. 5, 6, 7 and 8.

3. CALIBRATION OF EQUIPMENT

The thermocouples are continuous from the hot junction to the terminals in the cold junction, which largely eliminated parasitic thermal electro-motive forces.

The thermocouples were calibrated (together with their galvanometers) by inserting them in small cavities in a copper block, previously heated to 200°C and left to cool. The temperature of the copper block was measured by means of a mercury thermometer, that of the cold junction by the thermometers installed on the apparatus. Readings, as set out in Table No. C 1, were taken at appropriate intervals.

During sampling, the flue gas temperature is thus found as the sum of cold junction temperature and galvanometer deflection, converted to degrees of temperature.

3.1 Nozzle Calibration

(a) Introductory Remarks:

The purpose of this calibration is to establish the relationship between the volume rate of flow through the cyclone and the pressure drop occurring in the nozzle. By calculation this relation can then be converted into that between pressure drop and linear velocity in the probe.

Though conditions during calibration differ from those during actual use (as the calibration is carried out using air at room temperature and pressure), these differences have usually no significant effect.

(b) Method of Calibration:

The experimental set-up during calibration is indicated in Figure 4. It will be noted that calibration

was/...

was effected on the complete sampling head, i.e. the orifice was preceded by the probe and the filter; the pressure drop during calibration does thus not differ materially from that experienced during the test.

The volume rate of flow was measured by means of a Fisher and Porter Rotameter (No. B4-21-10 with stainless steel float No. BSVT-45). According to the manufacturer's calibration data, the flow rate is proportional to the instrument reading in the range from 8% to 100% of the maximum flow, where 100% corresponds to a flow rate of 2.48 ft³/minute of air at 70°C and 14.7 lbs/in² abs. These statements were verified and found to be substantially correct. (c.f. Table C 3). The manufacturers further state that viscosity effects are negligible and that adjustments for other conditions are to be made on the basis of the density.*

During calibration, nozzle pressure drop, rotameter reading, pressure at rotameter intake, air pressure and temperature were recorded. (The humidity during these tests was so low that the air density was not appreciably affected.)

(c) Evaluation of Orifice Calibration Test Data

These test data are tabulated in Table No. C 3, and are evaluated as follows:

The rotameter flow rates listed in Table C 2 are those for the atmospheric conditions operative during the experiment. As, however, a slight pressure drop, p_r,

occurs/...

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* In principle, the rotameter is a slightly tapered vertical tube through which the fluid is passed from bottom to top. In doing so, the medium has to force its way past the float, which then assumes such a position that the pressure difference across the annular space between float and tube wall balances the float weight W, hence

$$W = \frac{K\gamma}{2g} v_a^2$$

where γ is the density of the fluid, K a constant and v_a the velocity in the annulus. Hence it follows that if the density γ_1 at a particular test differs from that at the standard condition, γ_0 (70°C, 14.7 psia, air), the actual volume flow rate Q_1 for a particular deflection, say 100%, has to be derived from the "standard" quantity at 100% according to the equation

$$Q_1 = Q_0 \sqrt{\gamma_0 / \gamma_1}$$

occurs at the rotameter point of entry, the air in the rotameter is a little lighter than at the probe entry. Consequently, the flow rate Q_1, as indicated by the rotameter, is a little higher than that at the probe entry, Q, the latter following from the former according to the equation:

$$Q = Q_1\sqrt{\frac{B - p_r}{B}}$$

where B equals the absolute air pressure, p_r the pressure drop at the rotameter, expressed in the same units. As

$$p_r \ll B, \quad Q = Q_1(1 - \frac{p_r}{2B}) .$$

Table No. C 4 then shows the corrected flow rate, expressed in terms of the linear velocity v_2 in the probe in relation to the pressure drop across the nozzle. As both ½" and ⅜" nominal bore probes may be used, data for both probes are incorporated.

(d) Use of Test Data

In practice, during the actual sampling procedure the velocity v_2 in the probe has to be made equal - as nearly as possible - to the gas velocity v_1 at the sampling point. However, v_1 is not determined directly, but by means of the dynamic pressure $p_V = \frac{\gamma}{2g} v_1^2$ generated in the Pitot tube, and thus related to v_1 by a square law.

Likewise, the probe velocity v_2 follows indirectly from the nozzle pressure drop p_O, which is related to v_2, if not exactly by a square law, by an equation closely resembling such a law.

It thus appears expedient to relate the two quantities p_O and p_V, which are observed directly, to each other, as p_O and p_V may be expected to stand to each other in a nearly, though not necessarily absolutely, constant ratio.

One would thus express p_O in terms of the velocity head in the probe, i.e. one would put

$$p_O = \beta \frac{\gamma}{2g} v_2^2 = \beta p_V'$$

As already mentioned, the operator is provided with a table giving him the value of p_O to be maintained in relation to the velocity head p_V.

3.2/...

above data referring to the coal as fired, but on an ash-free basis.

Assuming 30% excess air, the composition of the wet flue gas would be:

CO_2	-	13% (on dry basis 14%)
O_2	-	4.6%
N_2+Ar	-	74.9%
H_2O	-	7.5%

(with air of 30% relative humidity at 27°C).

At 0°C and 760 mm. Hg. the (fictitious) density of such a flue gas would be 1.328 kg/m³. (0.0829 lbs/ft³).

5. TEST RESULTS:

The actual tests were performed on the lines set out in the previous paragraphs. The test results are represented in Tables 1 to 14, these being derived from the data sheets completed during the tests.

6. GAS VOLUMES AND ASH QUANTITIES:

6.1 Calculation of Gas Velocity in Duct

This velocity follows directly from the Pitot tube readings taken at the various sampling points. Denoting the velocity head by p_V, the velocity v_1 in the duct follows from the equation:

$$v_1 = \sqrt{\frac{2g}{\gamma} p_V}$$

where γ equals the specific gravity of the flue gas under test conditions and g the acceleration due to gravity. As p_V was determined in mm. H_2O, the velocity follows in m/sec. when g and γ are expressed in the appropriate metric units (m/sec² and kg/m³); conversion to feet per second requires multiplication by the factor 3.2808.

As the actual flue gas composition is not known at the present stage, a flue gas as indicated in paragraph 4, has been assumed to exist, with a fictitious density of 1.328 kg/m³ (0.0829 lbs/ft³) at 0°C and a pressure of 760 mm. Hg.

The/...

The data of Tables 5 to 8 have been treated as follows:-

(a) For each sampling point, the mean value of $\sqrt{p_v}$, resulting from the three readings taken at this point, has been obtained, using the indications of the inclined gauge.

(b) The density under actual conditions, γ_1 is then calculated from the assumed figure γ_0 = 1.328 kg/m³ at 0°C, 760 mm. Hg. by means of the conversion

$$\gamma_1 = \gamma_0 \frac{B}{760} \quad \frac{273}{T}$$

6.2 Calculation of the Aspiration Velocity

For each sampling point the average value of the three pressure-drop readings across the nozzle has been determined, the readings as tabulated in Tables 5 to 8 being used for this purpose.

Using the diagrams of Figure C 1, the value p_v', the velocity head in the probe may be read off for each value of p_o. The correction for the viscosity effect could be introduced at this point; it is, however, more convenient to do so in the final stage, i.e. when calculating the total quantity of gas aspirated.

From $\sqrt{p_v'}$ the velocity v' may be calculated in the same manner as in section (1), the results being shown in Tables 11, 12, 13 and 14.

6.3 Calculation of Flue Gas Volume and Gas Quantity Aspirated

(a) The velocity at each of the 24 sampling points is considered to be representative for the area in the centre of which this point is situated. As it is desired to calculate only the gas volume emitted by the boiler during the actual sampling period (24 x 10 minutes), the gas volume Q follows from the equation

$$Q = 240 \Sigma \frac{A_i}{144} \times 60 \; v_i = 100 \Sigma A_i \; v_i$$

where v_i equals the flue gas velocity (expressed in feet per second) in the sampling point i, and A_i the area of the surface (expressed in square inches) in which point i is situated, c.f. Table 15. The calculations are summarized in Tables 16 and 17.

(b) The quantity of gas aspirated, Q_2, follows from the consideration that sampling occurred through the area of the probe for a period of 600 seconds in each of the sampling points.

Consequently, in the point i the volume $Q_i = 600\ A_p . v_i$ is aspirated, where A_p denotes the probe area in ft², (c.f. Table C.4), and v_i the aspiration or probe velocity in feet per second. The total volume, exhausted during the test, thus equals $Q_2 = 600\ A_p \Sigma\ v_i$, where $\Sigma\ v_i$ is obtained from Tables 11, 12, 13 and 14.

The results of the calculation are shown in Tables 18 and 19.

These tables also indicate the ratio $Q : Q_2 = R$ (gas volume emitted to gas volume sampled) as well as the theoretical value R', following from the ratio of duct area to probe area, and the correction factor K, by means of which the quantity of dust, collected in the sampling equipment, has to be multiplied.

6.4 Gross Collector Efficiency and Dust Burden

The collector efficiency follows from the equation:

$$\eta = \frac{W_1}{W_1 + W_2} \quad 100\%$$

where W_1 equals the quantity of dust collected, W_2 the quantity of dust emitted, where both W_1 and W_2 have to be determined for identical periods. The latter may be calculated from $W = wQ/_{Q_2} K = wRK$, where w equals the weight of the dust collected in the sampling apparatus which has been indicated in Tables 16 and 17. This thus covers dust sampled in an active sampling period of 4 hours, but because of the time involved in changing the position of the probe every 10 minutes, the total sampling time t is longer than 4 hours.

TABLE NO. C 1

THERMOCOUPLE CALIBRATION

DATE: 1-3-1963

TEMPERATURE, °C			MILLIVOLTS		μ V/°C	
HOT JUNCTION	COLD JUNCTION	DIFF.	COUPLE NO. 1	COUPLE NO. 2	COUPLE NO. 1	COUPLE NO. 2
244	26	218	11.8	11.2	54.13	51.38
235	26	209	11.7	11.3	55.98	54.07
230	26	204	11.5	11.1	56.37	54.41
225	26	199	11.25	10.8	56.53	54.27
220	26	194	10.95	10.55	56.44	54.38
215	26	189	10.65	10.25	56.35	54.23
210	26	184	10.35	10.00	56.25	54.35
205	26	179	10.05	9.7	56.15	54.19
200	26	174	9.8	9.4	56.32	54.02
190	26	164	9.15	8.80	55.79	53.65
180	26	154	8.6	8.25	55.84	53.57
170	26	144	8.0	7.70	55.56	53.47
160	26	134	7.4	7.10	55.22	52.98
150	26	124	6.8	6.55	54.84	52.82
140	26	114	6.2	6.00	54.39	52.63
130	26	104	5.65	5.45	54.33	52.40
120	26	94	5.10	4.90	54.26	52.13
110	26	84	4.50	4.35	53.57	51.79
100	26	74	3.95	3.80	53.38	51.35
90	26	64	3.40	3.35	53.13	52.34
80	26	54	2.85	2.70	52.78	50.00
70	26	44	2.25	2.17	51.14	49.32
60	26	34	1.70	1.65	50.00	48.53

AVERAGE: 54.73 52.71

TABLE NO. C 2

ORIFICE CALIBRATION

(Observed Data)

Test →		a	a	b	b
	Rotameter Reading	Pressure Drop at Rotameter Inlet	Pressure Drop across Orifice	Pressure Drop at Rotameter Inlet	Pressure Drop across Orifice
	%	mm. H_2O			
Orifice No. 1, ¼" dia.	20	7	2.87	9	2.44
	30	18	5.91	20	5.60
	40	33	10.07	34	10.26
	50	52	15.21	52	15.32
	60	70	21.27	74	21.71
	70	93	28.11	96	28.57
	80	120	36.07	124	36.39
	90	149	44.72	152	45.37
	100	182	54.47	180	54.86
	Date:	7/10/57		8/10/57	
	Temp.	21.5°C		24.3°C	
	Baro.	25.7" Hg.		25.7" Hg.	
Orifice No. 2, ¼" dia.	20	10	2.65	10	2.21
	30	22	5.56	21	5.58
	40	38	9.84	36	9.94
	50	56	15.42	55	15.45
	60	83	21.48	76	21.48
	70	110	28.89	100	28.72
	80	126	36.37	126	35.98
	90	150	45.79	154	45.34
	100	188	55.82	193	56.00
	Date:	7/10/57		8/10/57	
	Temp.	24.8°C		24.3°C	
	Baro.	25.6" Hg.		25.7" Hg.	

TABLE NO. C 3

ROTAMETER MAXIMUM FLOW RATE AND AIR DENSITY UNDER CALIBRATION CONDITIONS

Orifice No.	Orifice Dia.	Test No.	Max. Flow Rate ft³/min	Max. Flow Rate litres/min	Velocity in ½" Probe ft/sec	Velocity in ½" Probe m/sec	Air Density lbs/ft³	Air Density kg/m³
1	¼"	a	2.678	75.8	31.99	9.75	0.0642	1.029
		b	2.691	76.2	32.18	9.81	0.0636	1.019
2	¼"	a	2.698	76.4	32.91	10.03	0.0633	1.014
		b	2.691	76.2	32.84	10.01	0.0636	1.019

Standard Data and Conversion Factors:

AIR DENSITY: At 14.7 psia, 70°F (Rotameter Standard) — 0.0700 lbs/ft³
or 760 mm.Hg, 21.1°C — 1.200 kg/m³

At 760 mm. Hg, 0°C — 0.0807 lbs/ft³
1.293 kg/m³

Air density conversion:

$$\gamma_1 = \gamma_0 \frac{p_1}{p_0}\frac{T_0}{T_1} = 11.795\frac{B}{T},$$

where B = air pressure in inches Hg.
T = abs. temp. in °K.

ROTAMETER:

Flow rate at maximum (100%) indication

$Q_0 = 2.48$ ft³/min. air of 14.7 psia, 70°F

Under other conditions $Q_1 = Q_0\sqrt{\gamma_0/\gamma_1}$

PROBES:

No.	Diameter Nominal	Diameter Actual	Area cm²	1/Area cm⁻²
1	½"	1.284 cm.	1.295	0.7722
2	½"	1.274	1.270	0.7874
1	⅜"	0.955	0.7163	1.3961
2	⅜"	0.953	0.7133	1.4019

CONVERSION FACTORS:

1 ft³ = 28.317 litres
1 kg/m³ = 0.06243 lbs/ft³
1 gram/m³ = 0.4370 grains/ft³
1 kg = 2.20462 lbs.
1 gram = 15.432 grains.

1 mm.H_2O = 1 kg/m²
1 m. = 3.2808 ft
1 cm² = 0.1550 in²

TABLE NO. C 4

ORIFICE CALIBRATION

ORIFICE NO. 1, ¼"

	Rotameter Reading	Correction	½" Probe: Velocity in Probe	½" Probe: Velocity Head p_v	Pressure drop across Orifice p_o	⅜" Probe: Velocity Head p_v	Remarks
	%	%	m/sec	mm.H_2O	mm.H_2O	mm.H_2O	
a	20	0	1.95	0.199	2.87	0.650	Ratio of Velocity
	30	0.1	2.93	0.450	5.91	1.471	Head ⅜" Probe to
	40	0.2	3.89	0.794	10.07	2.595	½" Probe.
	50	0.3	4.87	1.245	15.21	4.069	$\left(\frac{1.284}{0.955}\right)^4 = 3.268$
	60	0.4	5.83	1.784	21.27	5.830	
	70	0.5	6.80	2.427	28.11	7.931	$\gamma = 1.029$
	80	0.7	7.75	3.153	36.07	10.30	
	90	0.8	8.71	3.982	44.72	13.01	$p_v = \frac{v^2}{19.05} = 0.0524\ v^2$
	100	0.9	9.66	4.899	54.47	16.01	
b	20	0	1.96	0.200	2.44	0.654	
	30	0.1	2.94	0.449	5.60	1.467	$\gamma = 1.019$
	40	0.2	3.91	0.795	10.26	2.598	
	50	0.3	4.90	1.249	15.32	4.082	$p_v = \frac{v^2}{19.23} = 0.0520\ v^2$
	60	0.4	5.87	1.792	21.71	5.856	
	70	0.6	6.84	2.433	28.57	7.951	
	80	0.7	7.80	3.164	36.39	10.34	
	90	0.9	8.75	3.981	45.37	13.01	
	100	1.1	9.71	4.903	54.86	16.02	

ORIFICE NO. 2, ¼"

	Rotameter Reading	Correction	½" Probe: Velocity in Probe	½" Probe: Velocity Head p_v	Pressure drop across Orifice p_o	⅜" Probe: Velocity Head p_v	Remarks
a	20	0	2.01	0.209	2.65	0.670	Ratio of Velocity
	30	0.1	3.01	0.468	5.56	1.500	Head ⅜" Probe to ½"
	40	0.2	4.00	0.827	9.84	2.651	Probe.
	50	0.3	5.00	1.293	15.42	4.144	
	60	0.4	6.00	1.861	21.48	5.965	$\left(\frac{1.274}{0.953}\right)^4 = 3.205$
	70	0.6	6.98	2.519	28.89	8.073	
	80	0.7	7.96	3.276	36.37	10.50	$p_v = \frac{v^2}{19.33} = 0.0517\ v^2$
	90	0.9	8.95	4.141	45.79	13.27	$\gamma = 1.014$
	100	1.1	9.92	5.088	55.82	16.31	
b	20	0	2.00	0.208	2.21	0.666	
	30	0.1	3.00	0.468	5.58	1.500	$\gamma = \frac{v^2}{19.23} = 0.0520\ v^2$
	40	0.2	3.99	0.828	9.94	2.654	
	50	0.3	4.98	1.290	15.45	4.134	
	60	0.4	5.98	1.860	21.48	5.961	$\gamma = 1.019$
	70	0.6	6.96	2.519	28.72	8.073	
	80	0.7	7.94	3.278	35.98	10.51	
	90	0.9	8.92	4.138	45.34	13.26	
	100	1.1	9.89	5.086	56.00	16.30	

TABLE NO. 1

DUST COLLECTED

DUST COLLECTOR TEST AT UMGENI POWER STATION, BOILER NO. 9

DATE: 26-11-1963

LOAD: E.C.R.

RIGHT HAND SIDE

TIME hr.min.	WEIGHT, lbs.			TIME hr.min.	WEIGHT, lbs.		
	INCREMENT		CUMULATIVE		INCREMENT		CUMULATIVE
9.15	28.5	6.0	34.5	13.15	22.0	7.5	489.5
9.30	18.5	5.0	58.0	13.30	22.0	7.5	519.0
9.45	17.0	6.0	81.0	13.45	25.0	8.5	552.5
10.00	18.5	5.5	105.0	14.00	22.5	8.5	583.5
10.15	19.5	5.5	130.0	14.15	23.0	7.5	614.0
10.30	19.5	7.0	156.5	14.30	22.5	8.5	645.0
10.45	28.5	7.5	192.5	14.45	22.5	7.5	675.0
11.00	19.5	7.0	219.0	15.00	21.5	8.5	705.0
11.15	20.0	7.0	246.0	15.15	17.5	7.5	730.0
11.30	25.0	9.5	280.5	15.30	29.0	9.5	768.5
11.45	22.0	8.0	310.5	15.45	41.5	38.5	848.5
12.00	22.5	8.0	341.0	16.00	29.5	8.5	886.5
12.15	22.0	7.5	370.5	16.15	18.0	6.5	911.0
12.30	22.5	7.5	400.5	16.30	22.5	8.0	941.5
12.45	22.0	7.5	430.0	16.45	17.5	6.5	965.5
13.00	22.0	8.0	460.0	17.00	17.5	6.5	989.5

TABLE NO. 2

DUST COLLECTED

DUST COLLECTOR TEST AT UMGENI POWER STATION, BOILER NO. 9

DATE: 26-11-1963

LOAD: E.C.R.

LEFT HAND SIDE

TIME hr.min.	WEIGHT, lbs. INCREMENT		WEIGHT, lbs. CUMULATIVE	TIME hr.min.	WEIGHT, lbs. INCREMENT		WEIGHT, lbs. CUMULATIVE
9.15	13.0	19.5	32.5	13.15	13.0	19.5	539.0
9.30	11.5	16.0	60.0	13.30	13.5	19.5	572.0
9.45	11.0	17.5	88.5	13.45	14.5	21.5	608.0
10.00	10.5	16.5	115.5	14.00	13.5	19.5	641.0
10.15	10.5	18.5	144.5	14.15	12.5	19.5	673.0
10.30	11.0	19.0	174.5	14.30	13.5	20.5	707.0
10.45	12.5	19.0	206.0	14.45	14.5	19.5	741.0
11.00	14.0	18.0	238.0	15.00	12.5	20.5	774.0
11.15	12.0	19.0	269.0	15.15	12.5	17.5	804.0
11.30	15.5	26.0	310.5	15.30	16.5	27.5	848.0
11.45	11.5	16.5	338.5	15.45	35.5	45.5	929.0
12.00	12.5	20.5	371.5	16.00	13.5	12.5	955.0
12.15	13.0	18.5	403.0	16.15	11.5	16.0	982.5
12.30	14.0	20.0	437.0	16.30	12.5	21.5	1016.5
12.45	12.0	20.0	469.0	16.45	10.5	14.5	1041.5
13.00	13.0	24.5	506.5	17.00	10.5	15.5	1067.5

TABLE NO. 3

DUST COLLECTED

DUST COLLECTOR TEST AT UMGENI POWER STATION, BOILER NO. 9

DATE: 27-11-1963

LOAD: M.C.R.

RIGHT HAND SIDE

TIME hr.min.	WEIGHT, lbs.			TIME hr.min.	WEIGHT, lbs.		
	INCREMENT		CUMULATIVE		INCREMENT		CUMULATIVE
9.15	38.5	14.0	52.5	13.15	40.5	16.5	1078.0
9.30	45.5	17.5	115.5	13.30	45.5	24.5	1148.0
9.45	45.5	17.5	178.5	13.45	37.5	17.5	1203.0
10.00	45.5	18.0	242.0	14.00	38.5	16.5	1258.0
10.15	46.5	18.5	307.0	14.15	38.5	15.5	1312.0
10.30	53.5	27.5	388.0	14.30	37.5	15.5	1365.0
10.45	46.5	21.5	456.0	14.45	37.5	15.5	1418.0
11.00	43.5	17.5	517.0	15.00	45.5	17.5	1481.0
11.15	45.5	19.5	582.0	15.15	32.5	14.5	1528.0
11.30	43.5	18.5	644.0	15.30	44.5	18.0	1590.5
11.45	28.5	11.5	684.0	15.45	35.5	15.5	1641.5
12.00	64.5	31.5	780.0	16.00	64.5	49.5	1755.5
12.15	43.5	18.5	842.0	16.15	35.5	14.5	1805.5
12.30	43.5	18.5	904.0	16.30	39.5	18.5	1863.5
12.45	43.5	17.5	965.0	16.45	27.5	11.5	1902.5
13.00	39.5	16.5	1021.0	17.00	31.5	11.5	1945.5

TABLE NO. 4

DUST COLLECTED

DUST COLLECTOR TEST AT UMGENI POWER STATION, BOILER NO. 9

DATE: 27-11-1963

LOAD: M.C.R.

LEFT HAND SIDE

TIME hr.min.	WEIGHT, lbs. INCREMENT		WEIGHT, lbs. CUMULATIVE	TIME hr.min.	WEIGHT, lbs. INCREMENT		WEIGHT, lbs. CUMULATIVE
9.15	22.5	35.5	58.0	13.15	28.5	34.5	1093.0
9.30	25.5	40.0	123.5	13.30	26.5	36.5	1156.0
9.45	26.0	40.0	189.5	13.45	21.5	33.5	1211.0
10.00	24.5	38.5	252.5	14.00	23.5	32.5	1267.0
10.15	26.0	40.5	319.0	14.15	22.5	32.5	1322.0
10.30	30.0	42.0	391.0	14.30	23.5	32.5	1378.0
10.45	26.5	38.5	456.0	14.45	23.5	33.5	1435.0
11.00	27.5	39.5	523.0	15.00	25.5	39.5	1500.0
11.15	25.5	37.5	586.0	15.15	23.5	35.5	1559.0
11.30	25.5	37.5	649.0	15.30	24.5	35.5	1619.0
11.45	17.5	26.5	693.0	15.45	37.5	35.5	1692.0
12.00	36.5	52.5	782.0	16.00	62.5	61.5	1816.0
12.15	26.5	36.5	845.0	16.15	51.5	29.5	1897.0
12.30	25.5	35.5	906.0	16.30	25.5	44.5	1967.0
12.45	25.5	39.5	971.0	16.45	18.5	21.5	2007.0
13.00	24.5	34.5	1030.0	17.00	21.5	28.5	2057.0

TABLE NO. 5

DUST COLLECTOR TEST AT UMGENI POWER STATION, BOILER NO. 9

DATE: 26-11-1963
LOAD: E.C.R.

APPARATUS NO. 2
CYCLONE BEAKER NO. 2
FILTER NO. 2

LEFT HAND SIDE

SAMPLING POINT	TIME	VELOC. HEAD	ORIFICE P. DROP	STATIC PR.	FLUE GAS TEMP.	AMB. TEMP.	BARO.
	hr.min.	mm.H_2O	mm.H_2O	mm.H_2O	mV	°C	in. Hg.
A.1	11.30	4.8	17.5	6.0	5.4	37	28 13/16
	11.35	4.8	17.5	7.0	5.5	37	
	11.40	4.8	17.5	7.0	5.5	37	
A.2	11.41	6.2	22.5	9.0	5.5	37	
	11.46	6.3	22.8	8.0	5.5	37	
	11.51	6.2	22.4	8.0	5.5	37	
A.3	11.52	6.2	22.4	8.0	5.5	37	
	11.57	6.2	22.5	8.0	5.5	37	
	12.02	6.2	22.4	8.0	5.5	37	
A.4	12.03	6.0	22.0	9.0	5.5	37	
	12.08	6.0	22.0	9.0	5.5	37.5	
	12.13	6.0	22.0	8.0	5.5	37.5	
A.5	12.14	6.0	22.0	8.0	5.5	37.5	
	12.19	6.2	22.0	9.0	5.5	37.5	
	12.24	6.2	22.0	8.0	5.5	37.2	
A.6	12.25	4.0	15.0	7.0	5.5	37.2	
	12.30	4.0	15.0	8.0	5.6	37.5	
	12.35	4.2	15.0	7.0	5.6	37.6	

TABLE NO. 5
(Continued)

DUST COLLECTOR TEST AT UMGENI POWER STATION, BOILER NO. 9

DATE: 26-11-1963

LOAD: E.C.R.

APPARATUS NO. 2

CYCLONE BEAKER NO. 2

FILTER NO. 2

LEFT HAND SIDE

SAMPLING POINT	TIME	VELOC. HEAD	ORIFICE P. DROP	STATIC PR.	FLUE GAS TEMP.	AMB. TEMP.	BARO.
	hr.min.	mm.H_2O	mm.H_2O	mm.H_2O	mV	^oC	in. Hg.
B.1	12.47	5.5	20.0	8.0	5.3	37.1	28 13/16
	12.52	5.4	20.0	7.0	5.3	37.2	
	12.57	5.6	20.0	8.0	5.3	37.2	
B.2	12.58	6.4	23.5	7.0	5.5	37.4	
	13.03	6.5	23.5	9.0	5.5	37.2	
	13.08	6.4	23.8	8.0	5.5	37.2	
B.3	13.09	6.4	23.2	8.0	5.55	37.2	
	13.14	6.4	23.3	8.0	5.5	37.0	
	13.19	6.3	23.0	9.0	5.5	37.0	
B.4	13.20	6.5	23.4	8.0	5.6	37.0	
	13.25	6.6	24.0	8.0	5.6	36.6	
	13.30	6.6	24.0	8.0	5.6	36.4	
B.5	13.31	6.6	23.9	7.0	5.6	36.4	
	13.36	6.6	24.0	8.5	5.6	36.3	
	13.41	6.6	23.5	8.0	5.5	36.3	
B.6	13.42	4.4	16.0	7.0	5.5	36.4	
	13.47	4.4	16.0	8.0	5.5	37.2	
	13.52	4.4	16.2	7.5	5.5	38.0	

TABLE NO. 6

DUST COLLECTOR TEST AT UMGENI POWER STATION, BOILER NO. 9

DATE: 26-11-1963

LOAD: E.C.R.

APPARATUS NO. 2

CYCLONE BEAKER NO. 2

FILTER NO. 2

RIGHT HAND SIDE

SAMPLING POINT	TIME	VELOC. HEAD	ORIFICE P. DROP	STATIC PR.	FLUE GAS TEMP.	AMB. TEMP.	BARO.
	hr.min.	mm.H_2O	mm.H_2O	mm.H_2O	mV	°C	in. Hg.
C.1	14.28	5.2	19.0	12.0	5.5	40.0	28 13/16
	14.33	5.5	20.0	14.0	5.5	40.9	
	14.38	5.6	20.0	13.0	5.5	40.8	
C.2	14.39	5.8	22.0	13.0	5.5	41.0	
	14.44	6.0	22.0	13.0	5.53	41.0	
	14.49	6.0	22.0	14.0	5.5	41.0	
C.3	14.50	5.8	22.0	13.6	5.5	41.5	
	14.55	6.0	22.0	14.0	5.5	42.0	
	15.00	5.8	22.0	14.0	5.5	42.3	
C.4	15.01	5.5	20.0	13.0	5.5	42.3	
	15.06	5.4	20.0	12.0	5.5	42.5	
	15.11	5.5	20.0	13.0	5.5	42.8	
C.5	15.12	5.5	20.0	12.0	5.5	43.0	
	15.17	5.5	20.0	13.0	5.45	43.5	
	15.22	5.6	20.0	13.0	5.48	43.6	
C.6	15.23	5.4	20.0	12.0	5.45	43.6	
	15.28	5.4	19.5	12.0	5.4	43.7	
	15.33	5.4	19.0	12.0	5.4	43.8	

TABLE NO. 6
(Continued)

DUST COLLECTOR TEST AT UMGENI POWER STATION, BOILER NO. 9

DATE: 26-11-1963

LOAD: E.C.R.

APPARATUS NO. 2
CYCLONE BEAKER NO. 2
FILTER NO. 2

RIGHT HAND SIDE

SAMPLING POINT	TIME	VELOC. HEAD	ORIFICE P. DROP	STATIC PR.	FLUE GAS TEMP.	AMB. TEMP.	BARO.
	hr.min.	mm.H_2O	mm.H_2O	mm.H_2O	mV	^{o}C	in. Hg.
D.1	15.45	5.5	21.0	12.0	5.4	44	28 13/16
	15.50	5.8	21.0	13.0	5.4	44	
	15.55	5.8	21.0	13.0	5.4	44	
D.2	15.56	5.8	21.0	13.0	5.4	44	
	16.01	5.8	20.5	13.0	5.4	44	
	16.06	5.8	21.0	13.0	5.45	44	
D.3	16.07	6.0	22.5	13.0	5.45	44	
	16.12	5.8	21.0	13.0	5.45	44	
	16.17	5.8	20.5	13.0	5.40	44	
D.4	16.18	5.8	21.0	14.0	5.45	44	
	16.23	5.8	20.5	13.0	5.5	44	
	16.28	5.8	21.0	15.0	5.5	43.5	
D.5	16.29	5.8	21.5	14.0	5.5	43.8	
	16.34	5.5	20.0	13.0	5.5	43.5	
	16.39	5.5	19.8	14.0	5.52	44.0	
D.6	16.40	5.2	18.5	13.0	4.50	44.0	
	16.45	5.0	18.0	15.0	4.50	43.8	
	16.50	5.2	19.0	14.0	4.50	43.8	

TABLE NO. 7

DUST COLLECTOR TEST AT UMGENI POWER STATION, BOILER NO. 9

DATE: 27-11-1963

LOAD: M.C.R.

APPARATUS NO. 1

CYCLONE BEAKER NO. 3

FILTER NO. 3

RIGHT HAND SIDE

SAMPLING POINT	TIME	VELOC. HEAD	ORIFICE P. DROP	STATIC PR.	FLUE GAS TEMP.	AMB. TEMP.	BARO.
	hr.min.	mm. H_2O	mm. H_2O	mm. H_2O	mV	°C	in. Hg.
D.1	10.34	7.2	25.5	6	5.7	38.5	28 13/16
	10.39	7.5	26.8	5	5.7	38.3	
	10.44	7.5	26.8	5	5.7	38.3	
D.2	10.45	7.2	25.5	6	5.8	38.3	
	10.50	7.5	26.5	7	5.8	38.3	
	10.55	7.5	26.5	7	5.85	38.3	
D.3	10.56	7.6	27.0	5	5.85	38.3	
	11.01	7.6	27.0	6	5.9	38.3	
	11.06	7.6	27.0	5	5.85	38.3	
D.4	11.07	7.6	27.0	6	5.85	38.3	
	11.12	7.6	27.0	6	5.85	38.3	
	11.17	7.6	27.0	6	5.85	38.5	
D.5	11.18	7.4	26.0	5	5.8	38.9	
	11.23	7.5	26.5	6	5.8	39.0	
	11.28	7.5	26.5	5	5.8	39.1	
D.6	11.29	7.4	26.0	4	5.8	39.2	
	11.34	7.4	26.0	5	5.75	39.3	
	11.39	7.5	26.5	6	5.75	39.5	

TABLE NO. 7
(Continued)

DUST COLLECTOR TEST AT UMGENI POWER STATION, BOILER NO. 9

DATE: 27-11-1963

LOAD: M.C.R.

APPARATUS NO. 1

CYCLONE BEAKER NO. 3

FILTER NO. 3

RIGHT HAND SIDE

SAMPLING POINT	TIME	VELOC. HEAD	ORIFICE P. DROP	STATIC PR.	FLUE GAS TEMP.	AMB. TEMP.	BARO.
	hr.min.	mm.H_2O	mm.H_2O	mm.H_2O	mV	^oC	in. Hg.
C.1	11.48	6.4	23.0	1	5.85	38.8	28 13/16
	11.53	6.6	24.0	1	5.85	38.3	
	11.58	6.8	24.5	1	5.80	38.1	
C.2	11.59	7.0	25.0	2	5.85	38.0	
	12.04	7.2	25.8	4	5.85	38.0	
	12.09	7.2	25.7	5	5.88	38.0	
C.3	12.10	7.2	25.8	5	5.88	38.0	
	12.15	7.4	26.0	6	5.90	38.0	
	12.20	7.4	26.0	6	5.90	38.0	
C.4	12.21	7.0	25.0	5	5.90	38.0	
	12.26	7.2	25.5	5	5.9	38.0	
	12.31	7.2	25.5	5	5.9	38.0	
C.5	12.32	6.8	24.0	5	5.9	38.0	
	12.37	6.8	24.5	5	5.9	38.0	
	12.42	7.0	25.0	6	5.85	38.0	
C.6	12.43	6.8	24.2	7	5.8	38.5	
	12.48	6.6	24.0	8	5.8	38.5	
	12.53	6.6	24.0	7	5.8	38.7	

TABLE NO. 8

DUST COLLECTOR TEST AT UMGENI POWER STATION, BOILER NO. 9

DATE: 27-11-1963

LOAD: M.C.R.

APPARATUS NO. 1

CYCLONE BEAKER NO. 4

FILTER NO. 5

LEFT HAND SIDE

SAMPLING POINT	TIME	VELOC. HEAD	ORIFICE P. DROP	STATIC PR.	FLUE GAS TEMP.	AMB. TEMP.	BARO.
	hr.min.	mm.H_2O	mm.H_2O	mm.H_2O	mV	^oC	in. Hg.
B.1	13.22	8.20	29.0	3	5.4	41	28 13/16
	13.27	8.20	29.0	0	5.45	41	
	13.32	8.40	30.0	2	5.60	40.5	
B.2	13.33	8.50	30.0	1	5.65	39.8	
	13.38	8.50	30.0	2	5.63	37.5	
	13.43	8.60	30.5	3	5.61	36.8	
B.3	13.44	8.50	30.0	2	5.60	36.8	
	13.49	8.60	31.0	1	5.60	38.6	
	13.54	8.50	30.5	2	5.55	39.2	
B.4	13.55	8.65	31.5	1	5.60	39.5	
	14.00	8.80	32.0	1	5.55	39.8	
	14.05	8.80	31.8	2	5.52	40.0	
B.5	14.06	8.70	31.0	0	5.50	40.0	
	14.11	8.70	31.5	1	5.50	40.2	
	14.16	8.80	32.0	0	5.50	40.3	
B.6	14.17	6.00	22.0	0	5.50	40.5	
	14.22	5.80	21.0	1	5.50	40.2	
	14.27	6.00	22.0	2	5.55	39.6	

TABLE NO. 8
(Continued)

DUST COLLECTOR TEST AT UMGENI POWER STATION, BOILER NO. 9

DATE: 27-11-1963
LOAD: M.C.R.

APPARATUS NO. 1
CYCLONE BEAKER NO. 4
FILTER NO. 5

LEFT HAND SIDE

SAMPLING POINT	TIME	VELOC. HEAD	ORIFICE P. DROP	STATIC PR.	FLUE GAS TEMP.	AMB. TEMP.	BARO.
	hr.min.	mm.H_2O	mm.H_2O	mm.H_2O	mV	^oC	in. Hg.
A.1	14.39	6.0	22.0	3	5.40	41	28 13/16
	14.44	6.2	22.5	1	5.40	41	
	14.49	6.3	22.8	2	5.40	41.2	
A.2	14.50	8.0	28.0	3	5.45	41.2	
	14.55	8.2	28.5	1	5.42	42.0	
	15.00	8.3	29.0	1	5.45	42.0	
A.3	15.01	8.4	30.0	2	5.35	42.0	
	15.06	8.5	30.0	1	5.35	42.1	
	15.11	8.4	29.0	2	5.30	42.3	
A.4	15.12	8.2	28.5	2	5.30	42.4	
	15.17	8.0	28.0	4	5.30	42.8	
	15.22	8.0	28.0	3	5.30	42.8	
A.5	15.23	7.6	27.0	1	5.30	43.0	
	15.28	7.5	26.5	2	5.30	42.5	
	15.33	7.5	26.5	2	5.28	43.0	
A.6	15.34	5.5	20.0	0	5.20	43.0	
	15.39	5.2	18.5	1	5.20	43.0	
	15.44	5.0	18.0	1	5.20	43.0	

TABLE NO. 9

DUST COLLECTOR TEST AT UMGENI POWER STATION, BOILER NO. 9	
E.C.R.	
CYCLONE BEAKER NO. 2	OVEN FOR 4 HOURS
26.6122	73.0654
25.3633	71.8424
1.2489	1.2230
FILTER NO. 2	
39.9786	39.9081
39.5425	39.5425
.4361	.3656
EXTRAS	
25.3694	25.3702
25.3633	25.3643
.0061	.0059
TOTAL WEIGHT OF DUST COLLECTED : 1.5945 gram	

TABLE NO. 10

DUST COLLECTOR TEST AT UMGENI POWER STATION, BOILER NO. 9	
M.C.R.	
CYCLONE BEAKER NO. 3 + FILTER NO. 3	OVEN FOR 4 HOURS
41.6822	41.6484
40.8435	40.8435
.8387	.8049
CYCLONE BEAKER NO. 4 + FILTER NO. 5	
50.7765	50.7408
49.1659	49.1659
1.6106	1.5749
TOTAL WEIGHT OF DUST COLLECTED : 2.3798 gram	

TABLE NO. 11

VELOCITIES IN DUCT AND PROBE

LOAD: E.C.R. DATE: 26-11-1963 LEFT HAND SIDE

SAMPLING POINT	AVERAGE TEMPERATURE	MEAN VELOCITY HEAD	MEAN VELOCITY IN SAMPLING POINT V_1	MEAN ORIFICE PRESSURE DROP	MEAN VELOCITY IN PROBE V_2
NO.	^{o}A	mm.H_2O	m/sec.	mm.H_2O	m/sec.
A.1	402	4.80	10.42	17.50	10.42
A.2	402	6.23	11.86	22.57	11.90
A.3	402	6.20	11.84	22.43	11.83
A.4	402	6.00	11.65	22.00	11.74
A.5	402	6.13	11.76	22.00	11.74
A.6	404	4.07	9.57	15.00	9.60
B.1	399	5.50	11.11	20.00	11.11
B.2	402	6.43	12.06	23.60	12.12
B.3	403	6.37	12.02	23.13	12.04
B.4	405	6.57	12.23	23.80	12.27
B.5	404	6.60	12.24	23.80	12.27
B.6	402	4.40	9.97	16.07	9.97

TABLE NO. 12

VELOCITIES IN DUCT AND PROBE

LOAD: E.C.R. DATE: 26-11-1963 RIGHT HAND SIDE

SAMPLING POINT	AVERAGE TEMPERATURE	MEAN VELOCITY HEAD	MEAN VELOCITY IN SAMPLING POINT V_1	MEAN ORIFICE PRESSURE DROP	MEAN VELOCITY IN PROBE V_2
NO.	^{o}A	mm.H_2O	m/sec.	mm.H_2O	m/sec.
C.1	402	5.43	11.08	19.67	11.07
C.2	403	5.93	11.59	22.00	11.76
C.3	402	5.87	11.52	22.00	11.74
C.4	402	5.47	11.12	20.00	11.15
C.5	402	5.53	11.18	20.00	11.15
C.6	401	5.40	11.04	19.50	10.99
D.1	400	5.80	11.42	21.00	11.42
D.2	401	5.80	11.44	20.83	11.39
D.3	401	6.77	12.36	21.33	11.49
D.4	402	5.80	11.45	20.83	11.40
D.5	403	5.60	11.27	20.43	11.27
D.6	384	5.13	10.53	18.50	10.44

TABLE NO. 13

VELOCITIES IN DUCT AND PROBE

LOAD: M.C.R. DATE: 27-11-1963 LEFT HAND SIDE

SAMPLING POINT	AVERAGE TEMPERATURE	MEAN VELOCITY HEAD	MEAN VELOCITY IN SAMPLING POINT V_1	MEAN ORIFICE PRESSURE DROP	MEAN VELOCITY IN PROBE V_2
NO.	°A	mm.H_2O	m/sec.	mm.H_2O	m/sec
A.1	397	6.17	11.74	22.43	11.67
A.2	398	8.17	13.52	28.50	13.26
A.3	396	8.43	13.70	29.67	13.51
A.4	395	8.07	13.39	28.17	13.12
A.5	395	7.57	12.97	26.67	12.82
A.6	394	5.23	10.77	18.83	10.58
B.1	399	8.27	13.62	29.33	13.48
B.2	406	8.53	13.96	30.17	13.81
B.3	400	8.53	13.85	30.50	13.83
B.4	400	8.75	14.03	31.77	14.03
B.5	399	8.73	13.99	31.50	13.99
B.6	399	5.93	11.54	21.67	11.47

TABLE NO. 14

VELOCITIES IN DUCT AND PROBE

LOAD: M.C.R. DATE: 27-11-1963 RIGHT HAND SIDE

SAMP-LING POINT	AVERAGE TEMPER-ATURE	MEAN VELOCITY HEAD	MEAN VELOCITY IN SAMP-LING POINT V_1	MEAN ORIFICE PRESSURE DROP	MEAN VELOCITY IN PROBE V_2
NO.	^oA	mm.H_2O	m/sec.	mm.H_2O	m/sec.
C.1	404	6.60	12.25	23.83	12.16
C.2	405	7.13	12.74	25.50	12.63
C.3	406	7.33	12.94	25.90	12.74
C.4	406	7.13	12.76	25.33	12.60
C.5	406	6.86	12.52	24.50	12.37
C.6	404	6.67	12.31	24.07	12.20
D.1	403	7.40	12.95	26.36	12.82
D.2	404	7.40	12.97	26.16	12.75
D.3	405	7.60	13.11	27.00	13.03
D.4	405	7.60	13.11	27.00	13.03
D.5	404	7.46	13.02	26.33	12.84
D.6	404	7.43	12.99	26.16	12.82

TABLE NO. 15

DUCT AREA

POSITIONS	DIMENSIONS	AREA (EACH) in^2
A.1, A.2, A.3, A.4, A.5, A.6 B.1, B.2, B.3, B.4, B.5, B.6 C.1, C.2, C.3, C.4, C.5, C.6 D.1, D.2, D.3, D.4, D.5, D.6	95.5" x 39"	310.375

TABLE NO. 16

FLUE GAS VOLUME

	SAMPLING POINT	AREA (EACH)	RIGHT HAND SIDE		LEFT HAND SIDE	
	Number	in^2	Σ Vi m/sec.	Vol. Q. 10,000 ft^3 in 4 hours	Σ Vi m/sec.	Vol. Q. 10,000 ft^3 in 4 hours
E.C.R.	A.1,A.2,A.3,A.4,A.5,A.6 B.1,B.2,B.3,B.4,B.5,B.6 C.1,C.2,C.3,C.4,C.5,C.6 D.1,D.2,D.3,D.4,D.5,D.6	310.375	136 m/sec. 446.193 ft/sec.	1384.626	136.73 m/sec. 448.588 ft/sec.	1392.058

TABLE NO. 17

FLUE GAS VOLUME

	SAMPLING POINT	AREA (EACH)	RIGHT HAND SIDE		LEFT HAND SIDE	
	Number	in^2	Σ Vi m/sec.	Vol. Q. 10,000 ft^3 in 4 hours	Vi m/sec.	Vol. Q. 10,000 ft^3 in 4 hours
M.C.R.	A.1,A.2,A.3,A.4,A.5,A.6 B.1,B.2,B.3,B.4,B.5,B.6 C.1,C.2,C.3,C.4,C.5,C.6 D.1,D.2,D.3,D.4,D.5,D.6	310.375	153.67 m/sec. 504.166 ft/sec.	1564.528	157.08 m/sec. 515.353 ft/sec.	1599.244

TABLE NO. 18

VOLUME ASPIRATED

	SIDE	PROBE AREA (AP)	ΣV_2	VOLUME SAMPLED (Q_2)	RATIO VOLUME EMITTED TO VOLUME SAMPLED		CORRECTION FACTOR
		$X10^{-3}$ Ft^2	m/sec.	Ft^3	Actual (R)	Theoretical (R)	K.
E.C.R.	R.H.	.768	135.27 m/sec. 443.798 ft/sec.	204.502	33853	33678	1.005
	L.H.	.768	137.01 m/sec. 449.507 ft/sec.	207.133	33603	33678	0.998

TABLE NO. 19

VOLUME ASPIRATED

	SIDE	PROBE AREA (AP)	ΣV_2	VOLUME SAMPLED (Q_2)	RATIO VOLUME EMITTED TO VOLUME SAMPLED		CORRECTION FACTOR
		$X10^{-3}$ Ft^2	m/sec.	Ft^3	Actual (R)	Theoretical (R)	K.
M.C.R.	R.H.	0.771	151.99 m/sec. 498.654 ft/sec.	230.677	33911	33549	1.01
	L.H.	0.771	155.57 m/sec. 510.399 ft/sec.	236.110	33866	33549	1.009

TABLE NO. 20.

DUST EMISSION.

		UNIT	R.H.	L.H.	TOTAL.
M.C.R.	Weight of Ash Sampled (W)	Gram	0.8049	1.5749	2.3798
	Weight of Ash Emitted (E)	lb.	120.345	235.168	355.513
	Weight of Ash Collected in 4 Hours.	lb.	1012.8	958.4	1971.2

		UNIT	TOTAL
E.C.R.	Weight of Ash Sampled (W)	Gram	1.5945
	Weight of Ash Emitted (E)	lb	237.124
	Weight of Ash Collected in 4 Hours.	lb	1074.98

TABLE NO. 21.
E.C.R.

GRAIN SIZE.	EMITTED ASH ANALYSIS.	MASS OF ASH EMITTED.	COLLECTED ASH ANALYSIS	MASS OF ASH COLLECTED	FRACTIONAL EFFICIENCY.
Microns	%	lbs	%	lbs	%
0 - 1.4	1.63	3.87	0.53	5.69	59.52
1.4 - 3.3	4.88	11.57	1.36	14.62	55.82
3.3 - 5.0	16.26	38.56	3.18	34.18	46.99
5.0 - 7.4	23.88	56.63	5.39	57.94	50.57
7.4 - 11.6	33.69	79.89	9.33	100.30	55.66
11.6 - 19.2	14.03	33.27	8.72	93.74	73.81
19.2 - 23.7	1.71	4.05	3.60	38.70	90.53
> 23.7	3.92	9.29	67.85	729.37	91.49
TOTAL	100.00	237.13	99.96	1074.55	81.92

TABLE NO. 22

M.C.R.

GRAIN SIZE.	EMMITTED ASH ANALYSIS	MASS OF ASH EMMITTED	COLLECTED ASH ANALYSIS	MASS OF ASH COLLECTED	FRACTIONAL EFFICIENCY
Microns	%	lbs	%	lbs	%
1.0 - 1.4	3.35	11.91	0.54	10.64	47.18
1.4 - 3.3	6.02	21.40	1.47	28.98	57.52
3.3 - 5.0	13.75	48.88	2.96	58.35	54.42
5.0 - 7.4	35.85	127.45	4.87	96.00	42.96
7.4 - 11.6	28.43	101.07	7.99	157.50	60.91
11.6 - 19.2	5.44	19.34	7.86	154.94	88.90
19.2 - 23.7	1.14	4.05	3.13	61.70	93.84
23.7 - 26.6	0.55	1.96	1.54	30.36	93.93
>26.6	5.47	19.45	69.64	1372.74	98.60
TOTAL	100.00	355.513	100.00	1971.20	84.72

APPENDIX.

PARTICLE SIZE ANALYSIS OF FLY-ASH SAMPLES UMGENI POWER STATION.

Description of Samples :

The samples consisted of fly-ash from Umgeni Power Station and were designated as follows :

(a) E.C.R., probe sample;

(b) M.C.R., probe sample;

(c) E.C.R., primary collector sample (R.H.);

(d) E.C.R., secondary collector sample (R.H.);

(e) E.C.R., primary collector sample (L.H.);

(f) E.C.R., secondary collector sample (L.H.);

(g) M.C.R., primary collector sample (R.H.);

(h) M.C.R., secondary collector sample (R.H.);

(i) M.C.R., primary collector sample (L.H.);

(j) M.C.R., secondary collector sample (L.H.);

The average particle density for the samples was 2.185 gm/cc.

Method of Analysis :

A screen analysis was performed on samples (c) - (j). As requested, the analysis of samples (a) and (b) and the -325 mesh fractions of samples (c) - (j) was done by means of a Bahco Centrifugal Dust Classifier.

RESULTS :

Screen Analysis (Dry).

For each case three samples were analysed and all subsequent calculations were based on the mean values obtained.

(c) E.C.R., ...

(c) E.C.R., primary collector sample (R.H.).

Size fraction	Sample A	Sample B	Sample C	Average
Mesh	grams	grams	grams	grams
<60	21.15	20.76	21.39	21.10
60-100	22.81	22.60	22.43	22.61
100-150	13.18	19.95	12.92	13.02
150-200	2.91	2.70	2.80	2.80
200-325	7.75	6.92	7.16	7.26
>325	32.20	34.07	33.30	33.21

(d) E.C.R., secondary collector sample (R.H.).

Size fraction	Sample A	Sample B	Sample C	Average
Mesh	grams	grams	grams	grams
<60	3.00	2.98	3.17	3.05
60-100	9.22	9.25	9.55	9.34
100-150	14.84	16.78	18.79	16.80
150-200	6.04	5.55	4.62	5.40
200-325	22.34	21.07	21.60	21.67
>325	44.56	44.37	42.27	43.74

(e) E.C.R., primary collector sample (L.H.).

Size fraction	Sample A	Sample B	Sample C	Average
Mesh	grams	grams	grams	grams
<60	15.10	15.15	15.07	15.11
60-100	26.12	25.98	25.92	26.01
100-150	16.70	19.16	18.22	18.03
150-200	4.84	3.80	3.88	4.17
200-325	9.84	8.60	9.50	9.31
>325	27.40	27.31	27.41	27.37

(f) E.C.R., secondary collector sample (L.H.).

Size fraction	Sample A	Sample B	Sample C	Average
Mesh	grams	grams	grams	grams
<60	1.52	1.58	1.55	1.55
60-100	6.40	6.48	6.58	6.49
100-150	16.05	17.68	13.83	15.85
150-200	8.38	6.33	6.83	7.18
200-325	23.55	24.98	25.05	24.53
>325	44.10	42.95	46.16	44.40

(g) M.C.R., primary collector sample (R.H.).

Size fraction	Sample A	Sample B	Sample C	Average
Mesh	grams	grams	grams	grams
<60	34.14	34.38	34.44	34.32
60-100	18.85	18.88	18.55	18.76
100-150	11.47	10.32	10.15	10.65
150-200	2.80	3.40	3.05	3.06
200-325	6.75	7.37	7.39	7.17
>325	25.99	25.65	26.42	26.02

(h) ...../

(h) M.C.R., secondary collector sample (R.H.).

Size fraction	Sample A	Sample B	Sample C	Average
Mesh	grams	grams	grams	grams
<60	6.75	7.04	7.05	6.95
60-100	11.60	11.75	11.72	11.65
100-150	13.70	14.49	14.06	14.08
150-200	6.69	6.65	6.12	6.49
200-325	20.35	19.81	21.96	20.71
>325	40.91	40.26	39.09	39.08

(i) M.C.R., primary collector sample (L.H.).

Size fraction	Sample A	Sample B	Sample C	Average
Mesh	grams	grams	grams	grams
<60	26.24	26.02	25.89	26.05
60-100	21.80	22.00	21.75	21.85
100-150	12.29	12.44	12.68	12.47
150-200	3.82	3.39	3.42	3.54
200-325	7.60	7.70	7.60	7.63
>325	28.25	28.45	28.66	28.46

(j) M.C.R., secondary collector sample (L.H.).

Size fraction	Sample A	Sample B	Sample C	Average
Mesh	grams	grams	grams	grams
<60	4.45	4.41	4.42	4.43
60-100	9.64	9.67	9.74	9.65
100-150	16.51	15.40	18.02	16.68
150-200	6.82	5.84	5.16	5.94
200-325	23.25	22.85	21.14	22.41
>325	39.33	41.83	41.52	40.89

Bahco Analysis Results.

(a) E.C.R., probe sample: Sample weight: G_u = 1.1892 grams

Residue on screen: G_f = 0.0004 grams

Spacing Piece No.	Grain size limit, microns		Residue, grams		Cumalative weight % above grain size limit
	Ideal particle diameter d'	Actual particle diameter $d=d'/1.5\sqrt{\rho}$	G_a	$G_a + G_f$	
18.5	3.2	1.4	1.1694	1.1698	98.37
17	7.4	3.3	1.1114	1.1118	93.49
16	11.0	5.0	0.9180	0.9184	77.23
14	16.5	7.4	0.6341	0.6345	53.35
12	25.7	11.6	0.2334	0.2338	19.66
8	42.5	19.2	0.0665	0.0669	5.63
4	52.5	23.7	0.0462	0.0466	3.92
0	59.0	26.6	-	-	-

(b) M.C.R., probe sample: Sample weight: G_u = 1.9348 grams
Residue on screen: G_f = 0.0065 grams

Spacing Piece No.	Grain size limit, microns		Residue, grams		Cumalative weight % above grain size limit
	Ideal particle diameter d'	Actual particle diameter $d=d'/1.5\sqrt{\rho}$	Ga	Ga = Gf	
18.5	3.2	1.4	1.8635	1.8700	96.65
17	7.4	3.3	1.7470	1.7535	90.63
16	11.0	5.0	1.4810	1.4875	76.88
14	16.5	7.4	0.7873	0.7938	41.03
12	25.7	11.6	0.2373	0.2438	12.60
8	42.5	19.2	0.1320	0.1385	7.16
4	52.5	23.7	0.1100	0.1165	6.02
0	59.0	26.6	0.0993	0.1058	5.47

(c) E.C.R., primary collector sample (R.H.) (-325 mesh):
Sample weight: G_u = 14.1816 grams
Residue on screen: G_f = 0 grams

Spacing Piece No.	Grain size limit, microns		Residue, grams		Cumalative weight % above grain size limit
	Ideal particle diameter d'	Actual particle diameter $d=d'/1.5\sqrt{\rho}$	Ga	Ga + Gf	
18.5	3.2	1.4	13.9689	13.9689	98.50
17	7.4	3.3	13.1882	13.1882	93.00
16	11.0	5.0	11.4049	11.4049	80.42
14	16.5	7.4	8.6034	8.6034	60.67
12	25.7	11.6	4.5669	4.5669	32.20
8	42.5	19.2	1.9974	1.9974	14.08
4	52.5	23.7	1.2096	1.2096	8.53
0	59.0	26.6	0.9039	0.9039	6.37

(d) E.C.R., secondary collector sample (R.H.) (-325 mesh):
Sample weight: G_u = 13.6262 grams
Residue on screen: G_f = 0 grams

Spacing Piece No.	Grain size limit, microns		Residue, grams		Cumalative weight % above grain size limit
	Ideal particle diameter d'	Actual particle diameter $d=d'/1.5\sqrt{\rho}$	Ga	Ga + Gf	
18.5	3.2	1.4	13.4449	13.4449	98.67
17	7.4	3.3	13.0110	13.0110	95.49
16	11.0	5.0	12.0162	12.0162	88.18
14	16.5	7.4	10.3448	10.3448	75.92
12	25.7	11.6	7.2395	7.2395	53.13
8	42.5	19.2	4.0966	4.0966	30.06
4	52.5	23.7	2.7161	2.7161	19.93
0	59.0	26.6	2.1053	2.1053	15.45

(e) ...../

(e) E.C.R., primary collector sample (L.H.) (-325 mesh);
Sample weight : Gu = 14.2742 gms.
Residue on screen: Gf = 0 gms.

Spacing Piece No.	Grain size limit, microns		Residue, grams		Cumalative weight % above grain size limit.
	Ideal particle diameter d'	Actual particle diameter $d=d'/1.5\sqrt{\rho}$	Ga	Ga - Gf	
18.5	3.2	1.4	13.9890	13.9890	98.00
17	1.4	3.3	13.3564	13.3564	93.57
16	11.0	5.0	11.9190	11.9190	83.50
14	16.5	7.4	9.4356	9.4356	66.10
12	25.7	11.6	5.6520	5.6520	39.60
8	42.5	19.2	2.8109	2.8109	19.69
4	52.5	23.7	1.8765	1.8765	13.15
0	59.0	26.6	1.4714	1.4714	10.31

(f) E.C.R., secondary collector sample (L.H.) (-325 mesh)
Sample weight : Gu = 14.0319 gms.
Residue on screen : Gf = 0 gms.

Spacing Piece No..	Grain size limit, microns.		Residue, grams		Cumalative weight % above grain size limit.
	Ideal particle diameter d'	Actual particle diameter $d=d'/1.5\sqrt{\rho}$	Ga	Ga + Gf	
18.5	3.2	1.4	13.8800	13.8800	98.92
17.0	7.4	3.3	13.4940	13.4940	96.17
16.0	11.0	5.0	12.5334	12.5334	89.32
14	16.5	7.4	10.8426	10.8426	77.27
12	25.7	11.6	7.6934	7.6934	54.83
8	42.5	19.2	4.3794	4.3794	31.21
4	52.5	23.7	2.9222	2.9222	20.83
0	59.0	26.6	2.2920	2.2920	16.33

(g) M.C.R., primary collector sample (R.H.) (-325 mesh);
Sample weight : Gu = 14.6755 gms.
Residue on screen : Gf = 0 gms.

Spacing Piece No.	Grain size limit, microns.		Residue, grams		Cumalative weight % above grain size limit.
	Ideal particle diameter d'	Actual particle diameter $d=d'/1.5\sqrt{\rho}$	Ga	Ga + Gf	
18.5	3.2	1.4	14.4061	14.4061	98.16
17.0	7.4	3.3	13.6482	13.6482	93.00
16	11.0	5.0	11.8975	11.8975	81.07
14	16.5	7.4	8.9571	8.9571	61.03
12	25.7	11.6	4.9726	4.9726	33.88
8	42.5	19.2	2.4422	2.4422	16.64
4	52.5	23.7	1.5914	1.5914	10.84
0	59.0	26.6	1.1986	1.1986	8.17

(h) M.C.R., secondary collector sample (R.H.) (-325 mesh);
Sample weight : Gu = 15.1220 gms.
Residue on screen : Gf = 0 gms.

Spacing Piece No.	Grain size limit, microns.		Residue, grams		Cumalative weight % above grain size limit.
	Ideal particle diameter d'	Actual particle diameter $d=d'/1.5\sqrt{\rho}$	Ga	Ga + Gf	
18.5	3.2	1.4	14.8854	14.8854	98.44
17	7.4	3.3	14.2649	14.2649	94.33
16	11.0	5.0	13.1060	13.1060	86.67
14	16.5	7.4	11.2846	11.2846	74.62
12	25.7	11.6	8.1966	8.1966	54.20
8	42.5	19.2	4.7387	4.7387	31.34
4	52.5	23.7	3.2872	3.2872	21.72
0	59.0	26.6	2.5441	2.5441	16.82

(i) M.C.R., primary collector sample (L.H.) (-325 mesh);
Sample weight : Gu = 14.3961 gm.
Residue on screen : Gf = 0 gm.

Spacing Piece No.	Grain size limit, microns.		Residue, grams		Cumalative weight % above grain size limit.
	Ideal particle diameter d'	Actual particle diameter $d=d'/1.5\sqrt{\rho}$	Ga	Ga + Gf	
18.5	3.2	1.4	14.1673	14.1673	98.41
17	7.4	3.3	13.4883	13.4883	93.69
16	11.0	5.0	11.9565	11.9565	83.05
14	16.5	7.4	9.3138	9.3138	64.76
12	25.7	11.6	5.3756	5.3756	37.34
8	42.5	19.2	2.5863	2.5863	17.97
4	52.5	23.7	1.6601	1.6601	11.53
0	59.0	26.6	1.2428	1.2428	8.63

(j) M.C.R., secondary collector sample (L.H.) (-325 mesh)
sample weight : Gu = 14.5421 gm.
Residue on screen : Gf = 0 gm.

Spacing Piece No.	Grain size limit microns.		Residue, grams		Cumalative weight % above grain size limit.
	Ideal particle diameter d'	Actual particle diameter $d=d'/1.5\sqrt{\rho}$	Ga	Ga + Gf	
18.5	3.2	1.4	14.3629	14.3629	98.76
17	7.4	3.3	13.8515	13.8515	95.25
16	11.0	5.0	12.8871	12.8871	88.62
14	16.5	7.4	11.2882	11.2882	77.62
12	25.7	11.6	8.2990	8.2990	57.07
8	42.5	19.2	4.8112	4.8112	33.08
4	52.5	23.7	3.3532	3.3532	23.06
0	59.0	26.6	2.6417	2.6417	18.17.

COMPLETE ANALYSIS.

E.C.R.

Particle size range microns	PERCENTAGE			
	Right hand collector.		Left hand collector	
	Primary	Secondary	Primary	Secondary
> 251	21.10	3.05	15.11	1.55
251 - 150	22.61	9.34	26.01	6.49
150 - 104	13.02	16.80	18.03	15.85
104 - 75	2.80	5.40	4.17	7.18
75 - 44	7.26	21.67	9.31	24.53
44 - 26.6	2.12	6.76	2.82	7.25
26.6 - 23.7	0.72	1.96	0.78	1.99
23.7 - 19.2	1.85	4.43	1.79	4.61
19.2 - 11.6	6.02	10.09	5.45	10.49
11.6 - 7.4	9.45	9.97	7.25	9.96
7.4 - 5.0	6.56	5.34	7.46	5.35
5.0 - 3.3	4.18	3.19	2.76	3.04
3.3 - 1.4	1.83	1.39	1.21	1.22
<1.4	0.50	0.58	0.55	0.48
T O T A L	100.02	100.00	100.00	99.99

COMPLETE ANALYSIS.

M.C.R.

Particle Size range microns	PERCENTAGE.			
	Right hand collector		Left hand collector	
	Primary	Secondary	Primary	Secondary
> 251	34.32	6.95	26.05	4.43
251 - 150	18.76	11.69	21.85	9.65
150 - 104	10.65	14.08	12.47	16.68
104 - 75	3.06	6.49	3.54	5.94
775 - 44	7.17	20.71	7.63	22.41
44 - 26.6	2.13	6.74	2.46	7.43
26.6 - 23.7	0.70	1.97	0.83	2.00
23.7 - 19.2	1.51	3.85	1.83	4.10
19.2 - 11.6	4.49	9.17	5.51	9.81
11.6 - 7.4	7.06	8.18	7.79	8.41
7.4 - 5.0	5.21	4.83	5.22	4.49
5.0 - 3.3	3.10	3.07	3.03	2.71
3.3 - 1.4	1.34	1.64	1.34	1.44
<1.4	0.48	0.63	0.45	0.50
T O T A L	99.98	100.00	100.00	100.00

THE ANALYSIS OF THE COMPOSITE SAMPLE WAS CALCULATED EMPLOYING THE FOLLOWING RELATIONS :

(a) E.C.R.

(1) $\frac{\text{Total mass of dust caught L.H. secondary}}{\text{Total mass of dust caught L.H. primary}} = 1.494$

(2) $\frac{\text{Total mass of dust caught R.H. secondary}}{\text{Total mass of dust caught R.H. primary}} = 2.692$

(3) $\frac{\text{Total mass of dust caught L.H.}}{\text{Total mass of dust caught R.H.}} = 1.079$

(b) M.C.R.

(1) $\frac{\text{Total mass of dust caught L.H. secondary}}{\text{Total mass of dust caught L.H. primary}} = 1.349$

(2) $\frac{\text{Total mass of dust caught R.H. secondary}}{\text{Total mass of dust caught R.H. primary}} = 2.262$

(3) $\frac{\text{Total mass of dust caught L.H.}}{\text{Total mass of dust caught R.H.}} = 1.057$

ANALYSIS OF COMPOSITE SAMPLES (CALCULATED).

Particle size range microns.	PERCENTAGE.	
	E.C.R.	M.C.R.
> 251	7.44	14.47
251 - 150	13.65	14.36
150 - 104	16.26	13.99
104 - 75	5.36	5.17
75 - 44	18.10	16.33
44 - 26.6	5.48	5.32
26.6 - 23.7	1.56	1.54
23.7 - 19.2	3.60	3.13
19.2 - 11.6	8.72	7.86
11.6 - 7.4	9.33	7.99
7.4 - 5.0	5.39	4.87
5.0 - 3.3	3.18	2.96
3.3 - 1.4	1.36	1.47
< 1.4	0.53	0.54
TOTAL	99.96	100.00

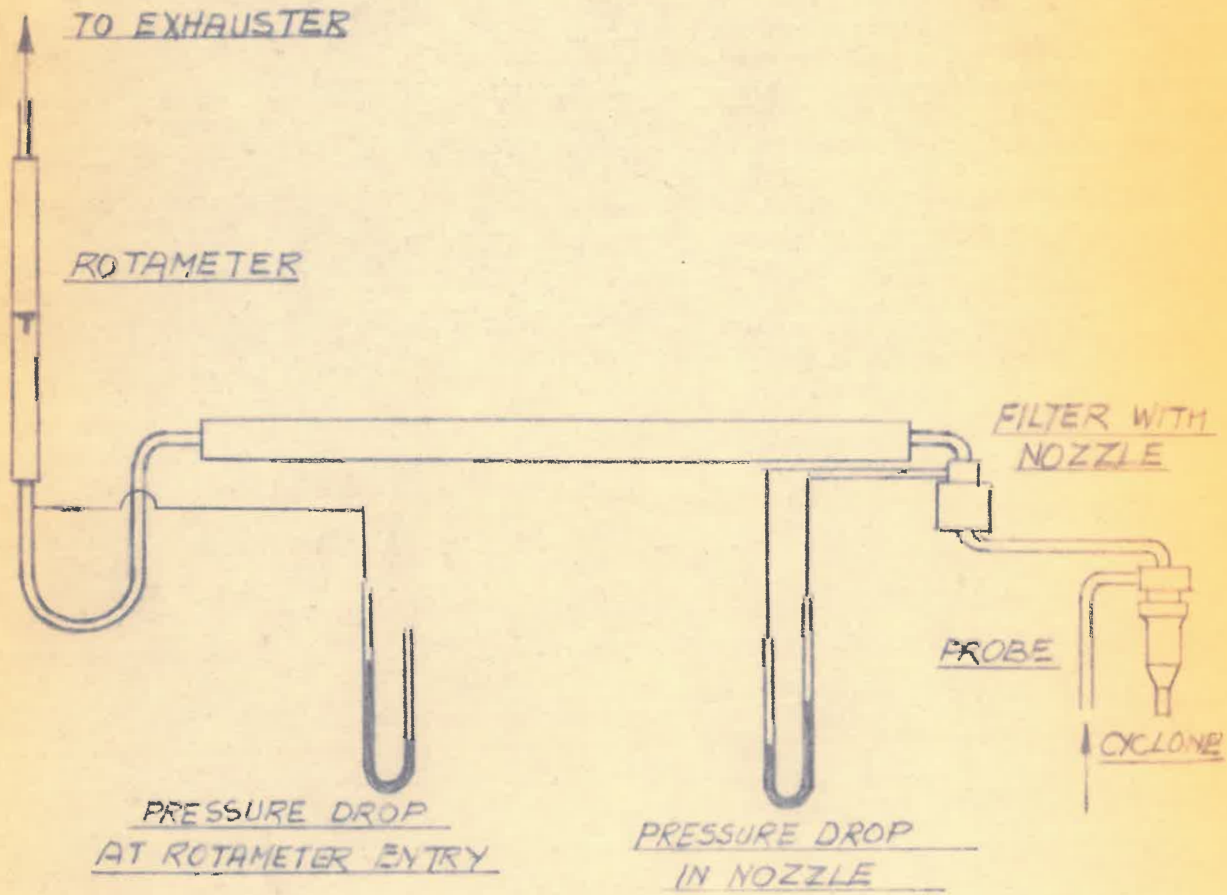


FIG. 4 : SET-UP FOR CALIBRATION OF NOZZLE

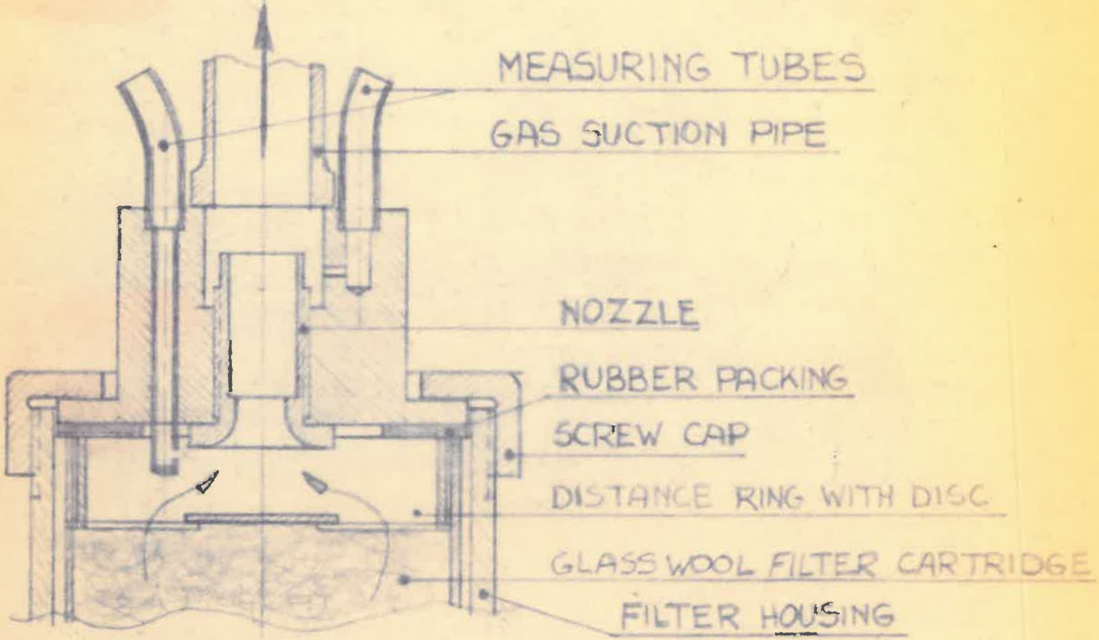
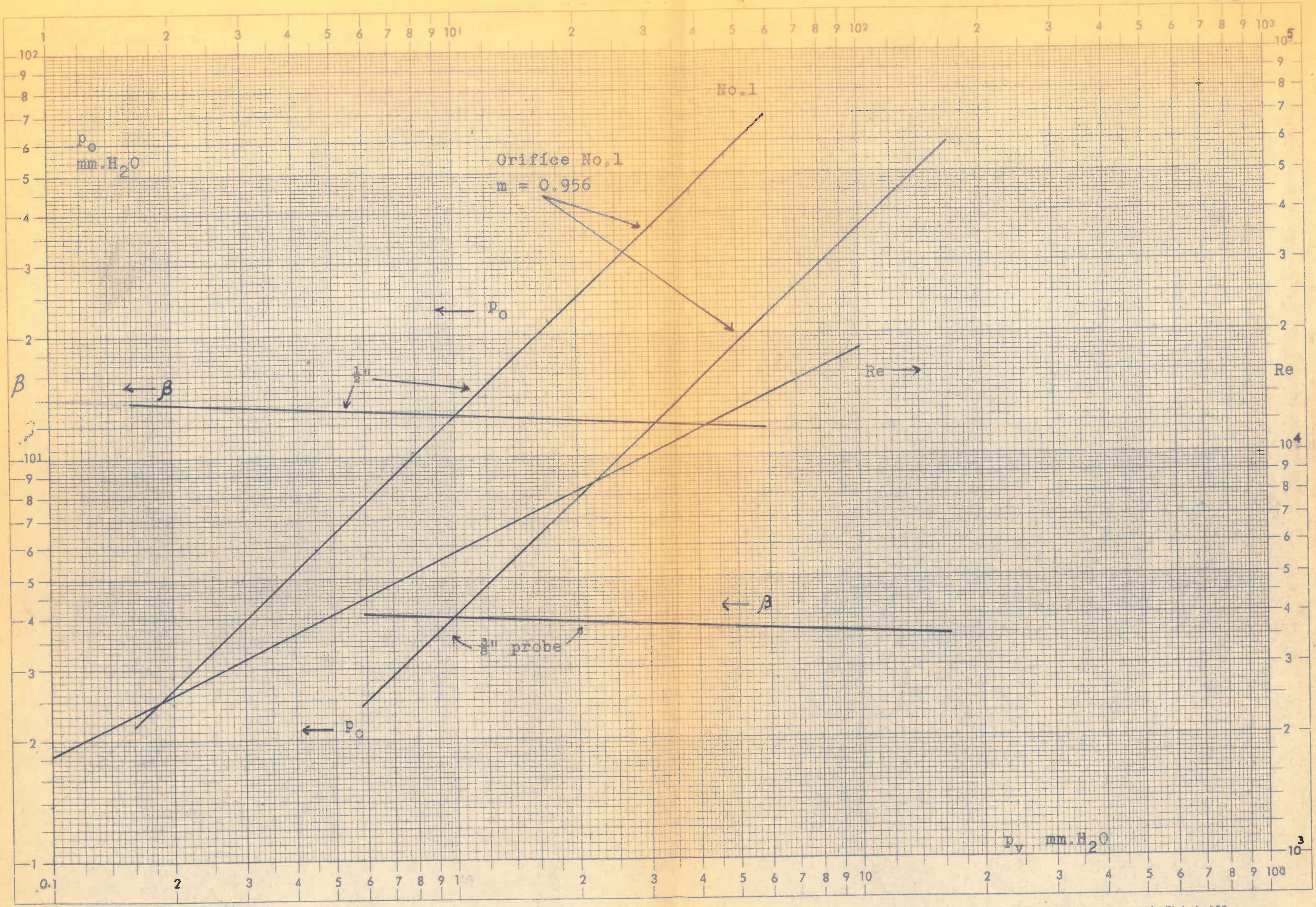


FIG. 2

FILTER HEAD AND NOZZLE



Beide Achsen logar. geteilt, eine von 1 bis 100, die andere bis 1000, Einheit 100 mm.

FIGURE C1a

Calibration Curves for Apparatus No. 1.

Note: This figure is for the purpose of illustration only and of reduced size compared with the diagram from which the ratio $p_c \div p_v$ is determined.

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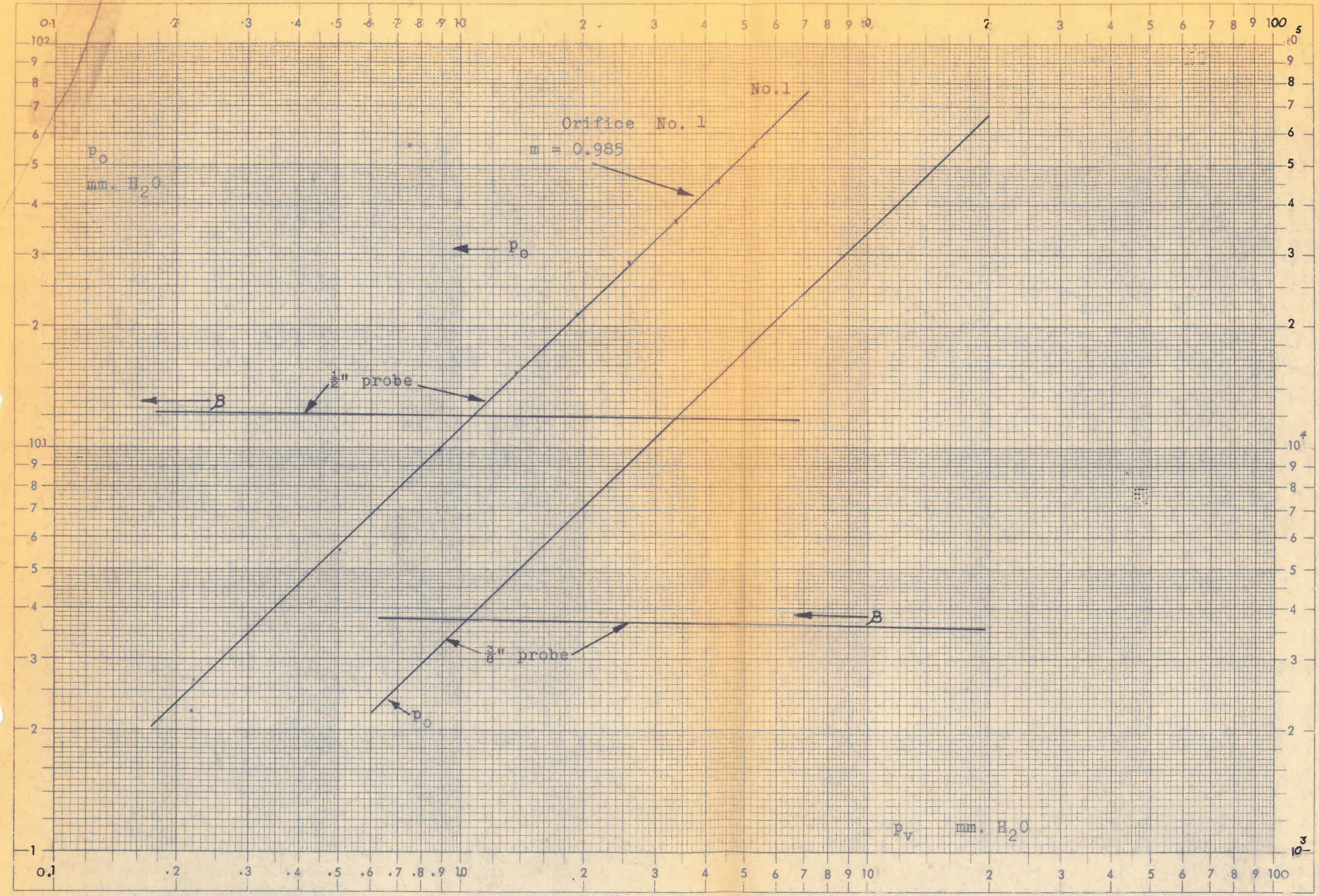

FIGURE C 1b

Calibration Curves of Apparatus No. 2.

Note: This figure is for the purpose of illustration only and of reduced size compared with the diagram from which the ratio p_o + p_v is determined.