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FUEL RESEARCH INSTITUTE OF SOUTH AFRICA.

REPORT ON DUST COLLECTOR TESTS AT SALT RIVER POWER STATION DURING ~~SEPTEMBER~~ Dec, 1957.

TECHNICAL MEMORANDUM NO.24 OF 1957.

By:
G.A.W.van Doornum.

FUEL RESEARCH INSTITUTE OF SOUTH AFRICA.

REPORT ON DUST COLLECTOR TESTS AT
~~SALT~~ RIVER POWER STATION DURING ~~OCTOBER~~,1957.

VIERFONTEIN December

TECHNICAL MEMORANDUM NO. ~~24~~ 1 OF 195~~7~~58.

1. INTRODUCTION.

The tests reported herein were carried out on behalf of Messrs. Davidson and Company, the suppliers of the dust collecting equipment, for the purpose of determining the performance of the installation.

International Combustion Co

boiler plant

The tests were performed concurrently with the boiler acceptance trial, the official tests taking place on October, 15th. and 16th., 1957.

The tests were carried out on the 4th Dec, 1957 on the dust collectors annexed to boiler no 16

2. 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.

2.1 Fine Ash Collected.

Determination of the quantity of fine ashes collected was a straightforward operation and consisted of weighing all the dust ~~deposited~~ caught by the primary and secondary collectors ~~in hoppers below the firing floor~~. To this effect the normal discharge valves to the main ash hopper were closed and there ducting was blocked. The pipes for discharge of the ash onto the basement floor terminated in flexible canvas connections, fitted to sheet metal covers, tightly fitting 44 gallon drums.

The ashes collected at the right and left-hand sides of the boiler were weighed at regular intervals, the results being given in Tables No. 3 and 6.

2.2. Flue Dust Sampling Equipment.

Flue dust sampling was carried out iso-kinetically and in accordance with B.S. 893: 1940. For this purpose, the sampling head illustrated in Figure 1a, 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.

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 in. diameter, through which the exhaust pipe, and measuring tubes and the thermocouple wires are passed.

The .../

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*Hereafter termed the orifice.

The equipment was designed to pass through 4" x 7" 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 and illustrated in Figure 1b, this apparatus contains -

(a) two exhauster fans, connected in series, which may be used either separately or together. The fan speed is controlled by means of a variable transformer;

(b) a sensitive diaphragm gauge and an inclined gauge (0 to 20 mm. by 0.2 mm. water column), connected in parallel to the Pitot tube, indicating the flue gas velocity head;

(c) a diaphragm gauge and a U-tube connected to pressure taps on both sides of the orifice plate; these gauges thus indicate 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 is measured by means of a mercury thermometer.

During some of the tests, the pressure at the orifice inlet was measured as well.

3. SAMPLING PROCEDURE.

In principle the test procedure is a follows:-

The sampling head is inserted in the duct and properly aligned in one of the sampling points (situated on a grid as illustrated in Figure 3), the exhaust line and all measuring tubes being closed by means of clamps (so as to avoid an untimely flow through the cyclone and damage to the pressure gauges). The measuring tubes are opened as soon as the equipment is in position. When the apparatus has - after approximately 15 minutes - attained the flue gas temperature, sampling may start. The fan is run at the estimated speed and the quick acting

clamp ..../

clamp on the exhaust line opened at the beginning of the sampling period. The fan speed is then readjusted to the correct value, corresponding to the Pitot tube indication and sampling is continued for the required period - 10 minutes in the present case. If necessary, the fan speed is re-adjusted from time to time; observations are recorded at 5-minute intervals. At the end of the sampling period, the exhaust is quickly closed and the sampling head transferred to another position. When all sampling points have been treated in this manner, the apparatus is finally withdrawn and opened. Any dust adhering to the interior of the apparatus is carefully transferred to the cyclone beaker (the dust collector proper) which together with the glass-wool filter is weighed after drying.

From the data thus obtained, the dust burden of the flue gas may be calculated, which in conjunction with the amount of dust recovered from the hopper, permits assessment of the collector performance,

The success of the operation therefore depends to a large extent on the accuracy with which the observer can adjust the exhaust velocity to the gas velocity in the duct. For correct isokinetic sampling, the pressure drop p_o across the orifice, has to be adjusted in a definite relation to the velocity head p_v measured by means of the Pitot tube. This relation is not always the same as it depends to some extent on the density of the flue gas and to a lesser degree also on its viscosity. These factors are affected mainly by the absolute pressure, temperature and composition of the gas and the correct relation can, in principle, be obtained by a fairly simple calculation based on the observed data.

In practice, however, the operator usually has little time available for this calculation, especially when conditions are not quite steady. He is thus provided with a table or diagram giving him the ratio $p_o \div p_v$ for an anticipated average condition, based on information collected during preliminary tests, which generally adequately covers the requirements of B.S.893:1940, which allows the exhaust velocity to deviate by + or -10% of the gas velocity.

The relation between p_o and p_v has thus been predetermined from the calibration data for the equipment in the manner set out hereunder:-

4. CALIBRATION .../

4. CALIBRATION OF EQUIPMENT.

4.1 Thermocouples.

The thermocouples are continuous from the hot junction to the terminals in the cold junction, which largely eliminates 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. C1 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.

4.2. Orifice 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 orifice. By calculation, this relation can then be converted into that between pressure drop and linear velocity in the probe.

However, unless very elaborate equipment is used, conditions during calibration differ from those during actual use, as the calibration is carried out, using air at room temperature and pressure.

(b) Method of Calibration:

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

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

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

Table No. C4 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 orifice. As both ½" and ⅜" nominal bore probes were used during the test, data for both probes are incorporated. (The figures tabulated refer to the actual probe diameters as listed in Table No. C3).
In addition Table No. C4 shows the velocity heads corresponding to the velocities.

(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 orifice pressure drop p_o, which is related to v_2, if not exactly by a square law, by an equation closely resempling 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

$$p_o = \beta \frac{\gamma}{2g} v_2^2$$

so that during the test isokinetic sampling is realised when $p_o = \beta p_v$, provided that it is possible to assess to what extent β is affected by the properties of the medium (i.e. to what extent the calibration data have to be modified when hot flue gas is substituted for air at room temperature and possibly a very much different absolute pressure).

Now, transfer from one set of conditions to another is best carried out on the basis of the Reynolds number $Re = \frac{vd}{\nu}$ (where v equals the linear velocity of the fluid relative to the object, d a characteristic linear dimension

of .../

of the system, ν the kinematic viscosity, all in self consistent units). It is customary* to give a resistance coefficient, like β, as a function of the Reynolds number and in this case the same value of β is obtained for all states characterised by the same Reynolds number.

Thus, if the calibration conditions are denoted by a single prime, the actual test conditions by a double prime,** $\beta' = \beta''$ when Re' = Re". One could thus, as indicated in Table No. C5, calculate $\beta' = p_o / \frac{\gamma}{2g} v_2'^2$ and the corresponding values of $Re' = \frac{v_2' d}{\nu'}$, d being in this case the probe diameter (say in cm.) ν' the kinematic viscosity of the air at room temperature (in stokes, approximately 0.17-19) while v_2' would then have to be entered in cm/sec.

It then appears that β is not absolutely constant.

In order to predict the value of β'' during sampling conditions, one should thus in the first place form an idea of the range of Reynolds numbers. This implies that the velocities in the sampling positions must be known, and also the viscosity of the flue gas. The former follows from a preliminary velocity survey; for the latter it is necessary to know the temperature of the flue gas and also the flue gas composition, primarily the CO_2 content and the absolute pressure. Fortunately, no great accuracy is required here, as firstly all these factors do not affect the viscosity to a very great extent, and secondly the variation of β with Re is not sharp. (This is the reason that the shape chosen for the restriction is actually a small shaped nozzle, and not an orifice, as the variation of β with Re is more gradual for the shaped nozzle than for the orifice. A small error in the estimation of Re has thus less effect on the value of β when using a nozzle).

It is thus feasible to calculate individually, for a number of values of p_v the corresponding magnitude of p_o. The process is, however, somewhat cumbersome, and the reverse process, viz. calculation of v_2'' from the observed value of p_o (necessary on completion of the test in order to compute the quantity of gas exhausted) even more so.

It is, however, possible to simplify this work considerably without any great loss of accuracy. To this effect the values of p_o and p_v, obtained upon calibration, are plotted on a double logarithmic co-ordinate system, as in <u>Figure 5</u>.

It .../

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*c.f. Spiers, Data on Fuel or Ower, Measurement of air flow.

**This distinction is only made in this chapter of the report.

It is then seen that the resulting curve is hardly distinguishable from a straight line, having the slope n - where n differs only very slightly from unity.

In other words

$$p_o = A\, p_v^{\,n}$$

or $$p_o = B\, v^{2n} \quad \text{(A, B and n being constant).}$$

As also $$p_o = \beta \frac{\gamma}{2g} v^2$$

it follows $$\beta = \frac{2gB}{\gamma} v^{2n-2} = K\, v^m, \quad (m = 2n - 2)$$

Again comparing two states of flow denoted by single and double primes one may expect that $\beta' = \beta''$ when $Re' = Re''$, or

$$\frac{v'd'}{\nu'} = \frac{v''d''}{\nu''}$$

As the thermal expansion of the probe may be neglected,

$$d' = d'' \quad \text{so} \quad \beta' = \beta'' = \beta \text{ when } \quad v'' = \frac{\nu''}{\nu'} v'$$

As one may also put $\beta' = K' v'^{m'}$ and $\beta'' = K'' v''^{m''}$, and as there is no reason to assume that m' will differ appreciably from m", it follows that the constant K", applying to the actual test follows from the corresponding constant K' - obtained by calibration - from the equation -

$$K'' = K' \left(\frac{\nu'}{\nu''}\right)^m$$

One may thus introduce a temperature correction factor

$$f_t = \frac{K''}{K'} = \left(\frac{\nu'}{\nu''}\right)^m$$

Consequently, when using the apparatus with a medium, having different properties from that with which the instrument was calibrated, only the effect of viscosity variations have to be taken into consideration. In addition, it may be shown that this viscosity effect is slight.

For the orifice used, n was of the order of 0.95 (exact figures are found in Figure 5), hence m = 2n - 2 = -0.1.

The kinematic viscosity of air during the calibration process was of the order of 0.18 stokes, that of the flue gas during the test of the order of ~~0.20~~ 0.24 (see section 5).

Hence $\frac{\nu'}{\nu''} = 0.9$, while $f_t = \sout{0.9^{-0.1}} = \sout{1.01}$. $0.75^{-0.1} = 1.03$

Therefore, when using the apparatus in hot flue gas, all values of β and thus also all ratios p_o/p_v as obtained during calibration, have to be multiplied by the factor f_t. The values of p_o

corresponding .../

corresponding to the velocity head p_v of the flue gas during the test may be determined graphically by shifting the curve a small distance to the left. This same curve may then be used in reverse in order to determine the quantity aspirated through the probe. The observed value of p_o now leads to the velocity head p_v corresponding to the probe intake velocity v_2, from which v_2 and the quantity aspirated Q_2 follow immediately.

As, however, the slope of the curve is very nearly equal to unity, this correction may be applied more simply by altering the values for p_v, as corresponding to the initial calibration curve, in the ratio $\frac{1}{f_t}$, or all velocities by $\frac{1}{\sqrt{f_t}}$, a correction of the order of ~~-0.5%~~)* -1,5%

4.3. Further Calibrations.

(a) All pressure gauges used during the test were compared with an Askania micro-manometer reading to 0.01 mm. water column. It appeared that the inclined gauges, used for measuring the velocity head were sufficiently accurate to take their indications at face value, provided they were properly levelled; theodolite type spirit levels were consequently fixed to these instruments.

The dial gauges, connected in parallel were mainly installed for convenience and though their readings have been reported, these should not be used for computation.

The U-tube and diaphragm gauges used for measuring the orifice pressure drop were likewise calibrated by comparison with the Askania instrument. Though the scale divisions of the two diaphragm gauges were not quite correct, the error was a consistent and proportional one. As these instruments could be read with greater precision than the simple U-tubes connected in parallel, their readings should preferably be used for computation, subject to the following correction:

Apparatus No. 1.

Actual pressure = instrument reading x 1.02.

Apparatus No. 2.

Actual pressure = instrument reading x 0.94

(b) A brief investigation was carried out for the purpose of establishing -

(i) whether the gas flow in the duct was seriously disturbed by introduction of the sampling apparatus.

(ii) whether the cyclone and filter affected the Pitot tube.

The ..../

~~*In this particular test the correction is particularly small, as the increase in viscosity of the flue gas is compensated by the difference in absolute pressure (approximately 650 mm Hg during calibration at Pretoria and 766 mm.Hg during the test in Cape Town.)~~

would be of the order of: ~~0.93~~ ~~0.76~~ 0.83 kg/m^3.

The viscosity of flue gas is not available in the literature. One may, however, form a rough estimate (sufficiently accurate for the present purpose) from the curves given in Spiers' Technical Data on Fuel (facing page 78 in the 4th. edition. The same handbook gives a mixing rule (on page 56). These data together lead to the conclusion that the kinematic viscosity of flue gas is approximately 0.20 stokes at 120°C and 760 mm.Hg; that of air at 25°C, 650 mm being roughly 0.18 stokes. (The kinematic viscosity is inversely proportional to the absolute pressure).

6. TEST RESULTS.

The actual tests were performed on the lines set out in the previous paragraphs. The test results are represented in Tables No. 1 to ~~7~~, 4 these being derived from the data sheets completed during the tests.

G.A.W. VAN DOORNUM.

PRINCIPAL TECHNICAL OFFICER.

PRETORIA.
12/12/57.

Tables 1-7 to be replaced see new text.

TABLE NO. 1.

DUST COLLECTOR TEST AT: SALT RIVER POWER STATION

FLUE SAMPLING

½" Probe — Boiler No. 1 80° MCR

DATE:	16-10-57	POSITION:	L
OBSERVER:	P.P. Williams	APPARATUS NO.	1
CYCL. BEAKER NO:	5	FILTER NO.	5

Sampling Point No.	Time	Velocity Head		Cyclone Drop		Static Press (Orifice)	Flue Gas Temp	Amb. Temp	Baro.
		Dial	Incl	Dial	U-Tube				
	Hr. Min	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.V.	°C	in.H_g
	Static Pressure in Duct in mm = 18								
A4	10.25	1.8	1.6	21	19	64	5.35	24.1	30 5/32
	10.30	2.0	1.6	21	20	64	5.38	23.8	
	10.35	1.9	1.6	21	20	64	5.39	23.7	
A5	10.36	1.3	1.0	13	11	50	5.39	23.5	
	10.41	1.2	1.0	13	12	50	5.4	23.4	
	10.46	1.2	1.0	13	12	50	5.4	23.2	
A6	10.47	3.4	3.0	37	35	102	5.4	23.1	
	10.52	2.8	2.6	32	32	90	5.33	23.1	
	10.57	3.0	2.6	32	32	92	5.32	23.2	
B6	11.00	3.8	3.0	37	36	102	5.29	23.8	
	11.05	3.6	3.2	39	38	104	5.27	24.3	
	11.10	3.6	3.2	39	38	104	5.25	24.6	
B5	11.11	1.2	1.0	13	13	50	5.23	24.7	
	11.16	1.2	1.0	13	12	50	5.22	25.0	
	11.21	1.2	1.0	13	13	50	5.20	25.3	
B4	11.22	1.2	1.0	13	12	50	5.19	25.4	
	11.27	1.2	1.0	13	13	51	5.11	25.7	
	11.32	1.2	1.0	13	13	50	5.09	26	
C4	11.34	2.0	1.6	21	20	66	5.09	26.2	
	11.39	2.1	1.8	23	21	70	5.08	26.3	
	11.44	2.0	1.8	23	22	70	5.07	26.5	
C5	11.45	2.1	1.8	23	22	70	5.06	26.6	
	11.50	2.1	1.8	23.	22	71	5.05	26.7	
	11.55	2.1	1.8	23	22	71	5.03	27	

Table No. 1 continued

DUST COLLECTOR TEST AT: SALT RIVER POWER STATION

FLUE SAMPLING

½" Probe — Boiler No. 1 80° MCR

DATE:	16-10-57	POSITION:	L
OBSERVER	P.P. Williams	APPARATUS NO:	1
CYCL. BEAKER NO:	5	FILTER NO:	5

Sampling Point	Time	Velocity Head		Cyclone Drop		Static Press. (Orifice)	Flue Gas Temp	Amb. Temp	Baro.
		Dial	Incl	Dial	U-Tube				
No.	Hr. Min	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.V.	°C	in.H_g
B2	1.38	1.8	1.6	21	21	69	5.50	28.3	
	1.43	2.2	1.8	23	23	74	5.46	28.1	
	1.48	2.2	1.8	23	23	74	5.37	28.0	
B3	1.49	1.5	1.2	16	16	60	5.38	28.0	
	1.54	1.4	1.2	16	16	60	5.42	28.0	
	1.59	1.6	1.2	16	16	60	5.42	28.0	
C3	2.02	2.2	2.0	26	25	81	5.46	28.0	30 5/32
	2.07	2.2	2.0	26	25	81	5.47	27.9	
	2.12	2.3	2.0	26	25	81	5.49	27.8	
C2	2.13	2.8	2.4	30	29	89	5.50	27.9	
	2.18	2.8	2.4	30	29	89	5.50	27.9	
	2.23	2.7	2.4	30	29	90	5.48	28.0	
C1	2.24	5.3	5.2	61	60	159	5.47	28.0	
	2.29	4.7	4.6	55	55	148	5.50	27.8	
	2.34	4.4	4.2	50	51	135	5.50	27.8	
D1	2.38	4.5	4.2	50	49	133	5.50	27.7	
	2.43	4.5	4.2	50	50	133	5.49	27.7	
	2.48	4.2	3.8	46	47	125	5.51	27.6	
D2	2.49	3.2	2.8	35	37	101	5.52	27.6	
	2.54	3.1	2.6	32	33	95	5.53	27.6	
	2.59	2.8	2.4	30	31	89	5.53	27.5	
D3	3.00	2.7	2.2	28	27	83	5.51	27.5	
	3.05	2.7	2.2	28	29	85	5.51	27.4	
	3.10	2.7	2.2	28	29	83	5.51	27.3	

TABLE NO. 2.

DUST COLLECTOR TEST AT: SALT RIVER II									
FLUE SAMPLING. ½" Probe 80% MCR Boiler No. 1									
DATE: 16-10-57					POSITION: R				
OBSERVER: S.F. Streicher					APPARATUS NO: 2				
CYCL. BEAKER NO: 2					FILTER NO: 1				
Sampling Point No.	Time	Velocity Head		Cyclone Drop		Static Press. (Orifice)	Flue Gas Temp	Amb. Temp	Baro.
		Dial	Incl	Dial	U-Tube				
	Hr. Min	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.V.	°C	in.H_g
	Static Pressure in duct 18 mm H_2O								
A7	10.25	1.6	1.4	16	14	52	5.1	25.0	30 5/32
	10.30	2.0	1.8	20	18	56	5.1	24.8	
	10.35	1.8	1.6	18	17	56	5.1	24.8	
A8	10.36	1.6	1.4	16	15	52	5.1	24.8	
	10.41	1.6	1.4	16	14	52	5.1	24.7	
	10.46	1.6	1.4	16	14	52	5.15	24.7	
	Static Pressure at probe 0.7" H_2O								
A9	10.47	1.8	1.6	18	16	53	5.2	24.7	
	10.52	2.0	1.8	20	18	56	5.15	24.7	
	10.57	2.0	1.8	20	18	56	5.15	24.8	
B7	10.59	2.0	1.8	20	18	56	5.10	25.1	
	11.04	2.0	1.8	20	18	56	5.10	25.3	
	11.09	2.0	1.8	20	18	56	5.10	25.6	
B8	11.10	1.6	1.4	16	15	52	5.10	25.8	
	11.15	1.8	1.6	18	16	54	5.10	25.9	
	11.20	1.8	1.6	18	16	53	5.10	26.2	
	Static Pressure at probe 0.75" H_2O								
B9	11.21	1.8	1.6	18	16	53	5.10	26.3	
	11.26	1.8	1.6	18	16	53	5.10	26.7	
	11.31	1.6	1.4	16	14	52	5.10	27.1	
C7	11.35	3.0	2.8	30	28	73	5.10	27.2	
	11.40	3.0	2.8	30	27	74	5.10	27.3	
	11.45	3.2	3.0	33	30	78	5.05	27.6	
C8	11.46	1.8	1.6	18	16	64	5.05	27.6	
	11.51	1.6	1.4	16	14	62	5.05	27.8	
	11.56	1.6	1.4	16	14	63	5.05	28.0	

Table No. 2 continued

DUST COLLECTOR TEST AT: SALT RIVER II

FLUE SAMPLING

½" Probe — 80% MCR Boiler No. 1

DATE:	16-10-57	POSITION:	R
OBSERVER:	S.F. Streicher	APPARATUS NO:	2
CYCL. BEAKER NO:	2	FILTER NO:	1

Sampling Point No.	Time	Velocity Head		Cyclone Drop		Static Press. (Orifice)	Flue Gas Temp	Amb. Temp	Baro.
		Dial	Incl	Dial	U-Tube				
	Hr. Min	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.V.	°C	in.H_g
C9	11.57	1.8	1.6	18	16	52	5.05	28.1	30 5/32
	12.02	1.8	1.6	18	16	52	5.00	28.2	
	12.07	1.8	1.6	18	16	52	5.00	28.3	
Static Pressure in duct 0.8" H_2O									
D7	12.10	6.0	5.6	55	51	123	5.00	28.9	
	12.15	6.2	5.8	59	54	132	5.00	29.1	
	12.20	6.2	5.8	59	54	132	5.00	29.2	
D8	12.21	3.2	3.0	33	31	85	5.05	29.3	
	12.26	3.0	2.8	30	28	78	5.00	29.7	
	12.31	2.8	2.6	28	26	75	5.00	29.9	
D9	12.32	3.2	3.0	33	30	82	5.00	30.0	
	12.37	3.4	3.2	35	32	85	5.05	30.0	
	12.42	3.4	3.2	35	32	86	5.00	30.0	
A10	12.46	2.6	2.4	26	24	72	5.00	29.9	
	12.51	1.6	1.4	16	14	56	4.90	29.9	
	12.56	3.0	2.8	30	28	78	5.10	30.0	
A11	12.57	2.4	2.2	24	22	68	5.15	30.0	
	13.02	2.2	2.0	22	20	64	5.25	30.2	
	13.07	2.2	2.0	22	20	64	5.20	30.2	
A12	13.08	6.8	6.4	65	62	148	5.15	30.3	
	13.13	6.9	6.6	67	64	150	5.10	30.3	
	13.18	6.8	6.4	65	62	130	5.10	30.5	
Static Pressure in duct 0.9" H_2O									
B10	13.25	1.6	1.4	16	15	58	5.10	30.7	
	13.30	1.2	1.0	12	11	51	5.00	30.8	
	13.35	1.2	1.0	12	11	50	4.90	30.8	

Table No. 2 continued

DUST COLLECTOR TEST AT: SALT RIVER II										
½" Probe		FLUE SAMPLING.				80% MCR Boiler No. 1.				
DATE: 16-10-57						POSITION: R				
OBSERVER: S.F. Streicher						APPARATUS NO: 2				
CYCL. BEAKER NO: 2						FILTER NO: 1				
Sampling Point	Time	Velocity Head		Cyclone Drop		Static Press. (Orifice)	Flue Gas Temp	Amb. Temp	Baro.
		Dial	Incl	Dail	U-Tube				
No.	Hr. Min	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.V.	°C	in.H_g
B11	13.36	1.2	1.0	12	11	50	48.5	30.7	30 5/32
	13.41	1.2	1.0	12	11	50	4.85	30.8	
	13.46	1.4	1.2	16	14	52	5.00	30.6	
B12	13.47	2.4	2.2	24	22	68	5.00	30.6	
	13.52	3.2	3.0	33	31	84	5.00	30.6	
	13.57	3.2	3.0	33	31	84	5.00	30.7	
C10	14.01	2.4	2.2	24	22	74	5.00	30.6	
	14.06	2.2	2.0	22	20	68	5.00	30.5	
	14.11	2.2	2.0	22	20	68	5.00	30.4	
C11	14.12	2.4	2.2	24	22	73	5.00	30.5	
	14.17	2.4	2.2	24	22	73	5.00	30.6	
	14.22	2.4	2.2	24	22	73	4.95	30.7	
C12	14.23	4.0	3.8	40	37	106	4.95	30.8	
	14.28	4.0	3.8	40	37	106	4.95	30.8	
	14.33	4.0	3.8	40	37	108	4.95	30.7	
Static Pressure in duct 1.0" H_2O									
D10	14.37	3.6	3.4	36	33	96	5.00	30.8	
	14.42	3.4	3.2	35	32	94	5.00	30.8	
	14.47	3.6	3.4	36	33	95	5.00	30.7	
D11	14.48	3.2	3.0	33	31	92	5.00	30.8	
	14.53	3.2	3.0	33	31	92	5.00	30.7	
	14.58	3.0	2.8	31	29	86	5.00	30.7	
D12	14.59	3.8	3.6	38	35	96	4.95	30.7	
	15.04	3.8	3.6	38	35	98	4.95	30.6	
	15.09	3.8	3.6	38	35	98	4.95	30.5	

TABLE NO. 3.

DUST COLLECTOR TEST AT: SALT RIVER POWER STATION									
COLLECTOR DUST WEIGHING: BOILER NO. 1 80% MCR									
DATE: 16-10-57					OBSERVER: P.J. Sorgedrager				
LEFT					RIGHT				
	INCREMENT			CUM.		INCREMENT			CUM.
	LB.					LB.			
TIME	GROSS	TARE	NETT		TIME	GROSS	TARE	NETT	
10.15	Start of Collector Test								
10.30	108½	55¾	52¾	52¾	10.30	100½	55¾	44¾	44¾
10.45	114¼	55¾	58½	111¼	10.45	105¾	55¾	50	94¾
11.00	111¾	55¾	56	167¼	11.00	105¾	55¾	50	144¾
11.15	115½	55¾	59¾	227	11.15	108¼	55¾	52½	197¼
11.30	115	55¾	60¼	287¼	11.30	119¼	55¾	63½	260¾
11.45	113¼	55¾	57½	344¾	11.45	109	55¾	53¼	314
12.00	118½	55¾	62¾	407½	12.00	114½	55¾	58¾	372¾
12.15	115¼	55¾	59½	467	12.15	115¼	55¾	59½	432¼
12.30	117½	55¾	61¾	528¾	12.30	118	55¾	62¼	494½
12.45	122½	55¾	66¾	595½	12.45	122¼	55¾	66½	561
13.00	117½	55¾	61¾	657¼	13.00	126½	55¾	70¾	631¾
13.15	112½	55¾	56¾	714	13.15	123½	55¾	67¾	699½
13.30	123¼	55¾	67½	781½	13.30	128¾	55¾	73	772½
13.45	108¼	55¾	52½	834	13.45	111½	55¾	55¾	828¼
14.00	123¾	55¾	68	902	14.00	128½	55¾	72¾	901
14.15	121	55¾	65¼	967¼	14.15	129	55¾	73¼	974¼
14.30	120¼	55¾	64½	1031¾	14.30	126¼	55¾	70½	1044¾
14.45	119¾	55¾	64	1095¾	14.45	128	55¾	72¼	1117
15.00	128¼	55¾	72½	1168¼	15.00	133½	55¾	77¾	1194¾
15.15	120½	55¾	64¾	1233	15.15	123¼	55¾	67½	1262¼
15.30	130¾	55¾	75	1308	15.30	132¼	55¾	76½	1338¾
15.45	118	55¾	62¼	1370¼	15.45	122¼	55¾	66½	1405¼
16.00	112½	55¾	56¾	1427	16.00	119¼	55¾	63½	1468¾
16.15	113	55¾	57¼	1484¼	16.15	121	55¾	65¼	1534
16.30	122¾	55¾	67	1551¼	16.30	125½	55¾	69¾	1603¾
16.45	115½	55¾	59¾	1611	16.45	121	55¾	65¼	1669
17.00	112¾	55¾	57	1668	17.00	120½	55¾	64¾	1733¾
17.15	117¾	55¾	62	1730	17.15	117½	55¾	61¾	1795½
17.30	115¼	55¾	59½	1789½	17.30	114½	55¾	58¾	1854¼

TABLE NO. 4.

DUST COLLECTOR TEST AT: SALT RIVER NO. 2

FLUE SAMPLING

⅜" Probe — Boiler No. 1 100% MCR

DATE: 17-10-57	POSITION: LH
OBSERVER: P.P. Williams	APPARATUS NO: 1
CYCL. BEAKER NO: 6	FILTER NO: 6

Sampling Point No.	Time	Velocity Head		Cyclone Drop		Static Press. (Orifice)	Flue Gas Temp	Amb. Temp	Baro.
		Dial	Incl	Dial	U-Tube				
	Hr. Min	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.V.	°C	in.H_g
	Static pressure in duct = 16 mm								
A3	10.20	3.4	3.0	12	13	42	5.47	29.5	30 1/16
	10.25	3.4	3.0	12	12	44	5.45	29.4	
	10.30	3.4	3.0	12	12	44	5.44	29.4	
A2	10.31	2.5	2.0	9	11	36	5.46	29.5	
	10.36	2.5	2.0	9	9	36	5.44	29.5	
	10.41	2.4	2.0	9	9	36	5.46	29.5	
A1	10.42	9.4	9.6	36	35	91	5.42	29.5	
	10.47	9.4	9.6	36	35	90	5.42	29.6	
	10.52	9.4	9.6	36	35	91	5.44	29.6	
B1	10.55	8.6	8.4	32	31	83	5.46	29.6	
	11.00	8.9	9.0	34	33	85	5.47	29.6	
	11.05	8.7	9.0	34	33	84	5.46	29.6	
B2	11.06	2.6	2.4	10	12	39	5.45	29.6	
	11.11	2.6	2.4	10	11	40	5.46	29.7	
	11.16	2.6	2.4	10	11	40	5.45	29.7	
B3	11.17	1.8	1.4	6	45	32	5.43	29.8	
	11.22	1.6	1.4	6	5	31	5.42	29.8	
	11.27	1.6	1.4	6	5	31	5.42	29.9	
	Static pressure in duct = 11 mm								
C3	11.30	2.5	2.0	9	9	36	5.42	30.0	
	11.35	2.3	2.0	9	10	36	5.42	29.9	
	11.40	2.5	2.2	9	9	36	5.42	29.8	
C2	11.41	3.8	3.4	14	15	46	5.45	29.8	
	11.46	3.8	3.4	14	15	46	5.47	29.7	
	11.51	3.8	3.6	15	15	48	5.48	29.7	

Table No. 4 continued

DUST COLLECTOR TEST AT: SALT RIVER NO. 2									
3/8" Probe			FLUE SAMPLING			Boiler No. 1 100% MCR			
DATE: 17-10-57					POSITION: LH				
OBSERVER: P.P. Williams					APPARATUS NO: 1				
CYCL. BEAKER NO: 6					FILTER NO: 6				
Sampling Point	Time	Velocity Head		Cyclone Drop		Static Press. (Orifice)	Flue Gas Temp	Amb. Temp	Baro.
		Dial	Incl	Dial	U-Tube				
No.	Hr. Min	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.v.	^oC	in.H_g
C1	11.52	8.7	9.4	35	34	88	5.48	29.7	
	11.57	8.7	9.4	35	34	89	5.50	29.7	
	12.02	8.8	9.4	35	34	88	5.51	29.6	
	Static pressure in duct = 16 mm								
D1	12.05	8.6	9.2	35	34	87	5.51	29.5	30 1/16
	12.10	8.8	9.2	35	34	87	5.51	29.5	
	12.15	8.8	9.2	35	34	87	5.51	29.5	
D2	12.16	6.2	6.2	24	23	69	5.52	29.5	
	12.21	6.0	5.8	23	23	67	5.51	29.5	
	12.26	6.0	5.8	23	23	67	5.52	29.4	
D3	12.27	5.2	5.0	20	19	62	5.52	29.4	
	12.32	5.1	4.8	19	19	58	5.52	29.4	
	12.37	5.1	4.8	19	19	59	5.52	29.3	
A4	12.44	1.8	1.6	7	65	34	5.47	29.3	
	12.49	2.1	1.8	8	7	36	5.47	29.3	
	12.54	2.1	1.8	8	7	36	5.48	29.3	
A5	12.55	2.4	2.0	9	75	38	5.47	29.3	
	12.60	2.4	2.0	9	8	38	5.47	29.3	
	1.05	2.4	2.0	9	8	39	5.46	29.3	
A6	1.06	4.9	4.6	19	175	61	5.43	29.4	
	1.11	5.0	4.6	19	18	61	5.43	29.4	
	1.16	4.8	4.6	19	18	61	5.42	29.5	
B6	1.19	5.3	5.0	20	19	62	5.43	29.4	
	1.24	5.3	5.0	20	19	63	5.42	29.4	
	1.29	5.3	5.0	20	19	63	5.41	29.4	

Table No. 4 continued

DUST COLLECTOR TEST AT: SALT RIVER NO. 2									
3/8" Probe			FLUE SAMPLING			Boiler No. 1		100% MCR	
DATE:	17-10-57				POSITION:		LH		
OBSERVER:	P.P. Williams				APPARATUS NO:		1		
CYCL. BEAKER NO:	6				FILTER NO:		6		
Samp-ling Point	Time	Velocity Head		Cyclone Drop		Static Press. (Ori-fice)	Flue Gas Temp	Amb. Temp	Baro.
		Dial	Incl	Dial	U-Tube				
No.	Hr. Min	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.V.	°C	in.H_g
B5	1.30	2.7	2.4	10	10	43	5.42	29.4	
	1.35	2.5	2.2	9	10	40	5.42	29.4	
	1.40	2.5	2.2	9	10	39	5.45	29.4	
B4	1.41	1.8	1.4	6	7	34	5.43	29.5	
	1.46	1.8	1.4	6	8	34	5.42	29.5	
	1.51	2.0	1.6	7	75	35	5.40	29.6	
C4	1.54	2.9	2.6	11	10	44	5.42	29.7	30 1/16
	1.59	2.9	2.6	11	10	45	5.42	29.7	
	2.04	3.0	2.6	11	10	45	5.42	29.8	
C5	2.05	3.1	2.8	12	12	48	5.43	29.9	
	2.10	3.2	2.8	12	12	49	5.43	29.9	
	2.15	3.2	2.8	12	12	48	5.44	29.9	
C6	2.16	5.6	5.4	21	22	68	5.42	29.8	
	2.21	5.8	5.6	22	22	70	5.42	29.8	
	2.26	5.8	5.6	22	22	71	5.43	29.8	
	Static pressure in duct = 17 mm								
D6	2.29	6.7	6.8	26	26	81	5.43	29.7	
	2.34	6.8	6.8	26	26	82	5.42	29.7	
	2.39	7.2	7.0	27	26	83	5.43	29.7	
D5	2.40	4.2	4.0	16	15	60	5.47	29.7	
	2.45	4.4	4.0	16	15	60	5.47	29.7	
	2.50	4.4	4.0	16	15	60	5.47	29.7	
D4	2.51	5.2	5.0	20	18.5	69	5.47	29.7	
	2.56	5.2	5.0	20	19	70	5.46	29.7	
	3.01	5.2	5.0	20	19	70	5.46	29.7	

TABLE NO. 5.

DUST COLLECTOR TEST AT: SALT RIVER NO. 2.

FLUE SAMPLING

3/8" Probe — Boiler No. 1 100% MCR

DATE:	17-10-57	POSITION:	RH
OBSERVER:	S.F. Streicher	APPARATUS NO:	2
CYCL. BEAKER NO:	7	FILTER NO:	2

Sampling Point No.	Time	Velocity Head		Orifice Drop		Static Press. (Orifice)	Flue Gas Temp	Amb. Temp	Baro.
		Dial	Incl.	Dial	U-Tube				
	Hr. Min	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.v.	°C	in.H_g
A10	10.20	3.6	3.4	12	11	40	5.20	27.4	30 1/16
	10.25	3.4	3.2	11	10	34	5.20	27.4	
	10.30	3.6	3.4	12	11	38	5.20	27.4	
	Static pressure in duct = 0.6" H_2O								
A11	10.31	2.4	2.2	8	7	30	5.25	27.6	
	10.36	2.4	2.2	8	7	30	5.20	27.7	
	10.41	2.2	2.0	7	7	28	5.20	27.8	
A12	10.42	11.8	11.0	36	32	74	5.20	27.9	
	10.47	11.8	11.0	36	32	75	5.20	27.8	
	10.52	12.0	11.2	37	33	77	5.20	27.8	
B10	10.55	2.4	2.2	8	7	30	5.20	27.9	
	11.00	2.2	2.0	7	7	31	5.20	28.0	
	11.05	2.6	2.4	9	8	34	5.20	28.0	
B11	11.06	2.8	2.6	9	8	35	5.20	28.1	
	11.11	2.8	2.6	9	8	34	5.20	28.1	
	11.16	2.6	2.4	9	8	34	5.20	28.2	
B12	11.17	7.7	7.4	25	22	54	5.20	28.4	
	11.22	7.6	7.4	25	23	56	5.20	28.7	
	11.27	7.6	7.4	25	23	56	5.20	28.8	
C10	11.30	2.8	2.6	9	8	34	5.15	28.9	
	11.35	2.8	2.6	9	8	34	5.15	28.8	
	11.40	2.8	2.6	9	8	34	5.20	28.8	
C11	11.41	3.4	3.2	11	10	36	5.20	28.8	
	11.46	3.4	3.2	11	10	36	5.20	28.8	
	11.51	3.4	3.2	11	10	36	5.20	28.7	

Table No. 5 continued

DUST COLLECTOR TEST AT: SALT RIVER NO. 2.									
3/8" Probe		FLUE SAMPLING			Boiler No. 1 100% MCR				
DATE:	17-10-57				POSITION:		RH		
OBSERVER:	S.F. Streicher				APPARATUS NO:		2		
CYCL. BEAKER NO:	7				FILTER NO:		2		
Sampling Point	Time	Velocity Head		Orifice Drop		Static Press. (Orifice)	Flue Gas Temp	Amb. Temp	Baro.
		Dial	Incl.	Dial	U-Tube				
No.	Hr. Min	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.V.	°C	in.H_g
C12	11.52	7.4	7.2	24	22	54	5.20	28.7	30 1/16
	11.57	7.2	7.0	24	22	56	5.25	28.7	
	12.02	7.0	6.8	23	21	55	5.25	28.7	
D10	12.05	4.4	4.2	14	12	42	5.25	28.6	
	12.10	4.7	4.6	16	14	46	5.25	28.7	
	12.15	4.8	4.6	16	14	46	5.25	28.7	
D11	12.16	4.4	4.2	14	12	44	5.25	28.7	
	12.21	4.6	4.4	15	13	45	5.25	28.7	
	12.26	4.8	4.6	16	14	46	5.30	28.5	
D12	12.27	7.4	7.2	24	22	56	5.30	28.6	
	12.32	7.2	7.0	24	22	56	5.30	28.5	
	12.37	7.0	6.8	23	21	55	5.30	28.5	
A7	12.43	3.2	3.0	11	10	36	5.25	28.2	
	12.48	3.4	3.2	11	10	38	5.25	28.1	
	12.53	3.4	3.2	11	10	40	5.30	28.0	
A8	12.54	2.4	2.2	8	7	34	5.30	28.0	
	12.59	2.6	2.4	9	8	35	5.30	28.0	
	13.04	2.6	2.4	9	8	36	5.30	28.0	
A9	13.06	2.6	2.4	9	8	36	5.30	28.0	
	13.11	2.8	2.6	9	8	36	5.30	28.0	
	13.16	2.8	2.6	9	8	36	5.30	27.9	
	Static pressure in duct = 0.7" H_2O								
B7	13.19	2.6	2.4	9	8	36	5.30	27.8	
	13.24	2.6	2.4	9	8	36	5.30	27.8	
	13.29	2.6	2.4	9	8	36	5.30	27.8	

Table No. 5 continued

DUST COLLECTOR TEST AT: SALT RIVER NO. 2									
3/8" Probe			FLUE SAMPLING			Boiler No. 1 100% MCR			
DATE: 17-10-57					POSITION: RH				
OBSERVER: S.F. Streicher					APPARATUS NO: 2				
CYCL. BEAKER NO. 7					FILTER NO: 2				
Sampling Point No.	Time	Velocity Head		Orifice Drop		Static Press (Orifice)	Flue Gas Temp	Amb. Temp	Baro.
		Dial	Incl.	Dial	U-Tube				
	Hr. Min	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.m.H_2O	m.V.	°C	in.H_g
B8	13.30	2.6	2.4	9	8	36	5.30	27.8	30 1/16
	13.35	2.6	2.4	9	8	36	5.30	27.8	
	13.40	2.8	2.6	9	8	36	5.30	27.8	
	Static pressure in duct = 0.6" H_2O								
B9	13.41	2.6	2.4	9	8	36	5.30	27.8	
	13.46	2.4	2.2	8	7	34	5.25	28.0	
	13.51	2.6	2.4	9	8	36	5.25	28.0	
C7	13.53	4.4	4.2	15	13	45	5.25	28.0	
	13.58	4.4	4.2	15	13	46	5.25	28.0	
	14.03	4.4	4.2	15	13	46	5.25	28.2	
C8	14.05	2.2	2.0	7	7	33	5.30	28.1	
	14.10	2.2	2.0	7	7	32	5.30	28.1	
	14.15	2.4	2.2	8	7	34	5.30	28.1	
C9	14.16	2.4	2.2	8	7	33	5.30	28.1	
	14.21	2.4	2.2	8	7	33	5.30	28.2	
	14.26	2.6	2.4	9	8	36	5.30	28.1	
D1	14.29	6.0	5.8	20	18	56	5.30	28.0	
	14.34	5.8	5.6	19	17	54	5.30	28.0	
	14.39	5.4	5.2	18	16	52	5.35	28.0	
	Static pressure in duct = 0.7" H_2O								
D8	14.40	4.6	4.4	15	14	46	5.35	28.0	
	14.45	2.8	2.6	9	8	37	5.35	28.1	
	14.50	2.6	2.4	9	8	36	5.35	28.0	
D9	14.51	2.8	2.6	9	8	35	5.35	28.1	
	14.56	3.0	2.8	10	9	38	5.35	28.0	
	15.01	3.0	2.8	10	9	38	5.35	28.0	

TABLE NO. 6.

DUST COLLECTOR TEST AT: SALT RIVER II POWER STATION									
COLLECTOR DUST WEIGHING: Boiler No. 1 100% MCR									
DATE: 17-10-57					OBSERVER: P.J. Sorgedrager				
LEFT					RIGHT				
	INCREMENT			CUM.		INCREMENT			CUM.
	LB.					LB.			
TIME	GROSS	TARE	NETT		TIME	GROSS	TARE	NETT	
10.15	Start of collector test								
10.30	138	55¾	82¼	82¼	10.30	129¼	55¾	73½	73½
10.45	144	55¾	88¼	170½	10.45	131¾	55¾	76	149½
11.00	148½	55¾	92¾	263¼	11.00	136¾	55¾	81	230½
11.15	153¾	55¾	98	361¼	11.15	139	55¾	83¼	313¾
11.30	155½	55¾	99¾	461	11.30	139¼	55¾	83½	397¼
11.45	158¼	55¾	102½	563½	11.45	141½	55¾	85¾	483
12.00	160½	55¾	104¾	668¼	12.00	144	55¾	88¼	571¼
12.15	155½	55¾	99¾	768	12.15	139½	55¾	83¾	655
12.30	153¼	55¾	97½	865½	12.30	138¼	55¾	82½	737½
12.45	156¾	55¾	101	966½	12.45	141	55¾	85¼	822¾
13.00	148¼	55¾	92½	1059	13.00	138¼	55¾	82½	905¼
13.15	144½	55¾	88¾	1147¾	13.15	130½	55¾	74¾	980
13.30	145½	55¾	89¾	1237½	13.30	133¾	55¾	78	1058
13.45	143	55¾	87¼	1324¾	13.45	127	55¾	71¼	1129¼
14.00	152¼	55¾	96½	1421¼	14.00	135½	55¾	79¾	1209
14.15	148	55¾	92¼	1513½	14.15	126¼	55¾	70½	1279½
14.30	146¾	55¾	91	1604½	14.30	128½	55¾	72¾	1352¼
14.45	143½	55¾	87¾	1692¼	14.45	129¾	55¾	74	1426¼
15.00	139¼	55¾	83½	1775	15.00	127½	55¾	71¾	1498
15.15	144¾	55¾	89	1864¾	15.15	133¼	55¾	77½	1575½

TABLE NO. 7.

DUST COLLECTED IN SAMPLING APPARATUS.

Test	Side	No.	Cyclone Beaker Weight, grams Full	Empty	No.	Glasswool Filter Weight, grams Full	Empty
80% M.C.R.	L.H.	5	149.1007	148.2929	5	36.6031	36.4965
80% M.C.R.	R.H.	2	155.4774	154.7572	1	38.5692	38.4454
100% M.C.R.	L.H.	6	155.0306	154.3293	6	36.1698	36.0415
100% M.C.R.	R.H.	7	159.6423	159.2076	2	36.5268	36.4266

TABLE NO. C 1

THERMOCOUPLE CALIBRATION.

Date: 28-8-1957

Temperature, °C			Millivolts		μV/°C	
Hot junction	Cold junction	Diff.	Couple No.1	Couple No.2	Couple No.1	Couple No.2
185.0	18.3	166.7	9.30	9.10	55.6	54.6
170.0	18.3	151.7	8.50	8.27	55.6	54.5
160.0	18.4	141.6	7.93	7.72	56.0	54.6
150.0	18.5	131.5	7.35	7.17	55.7	54.5
140.0	18.6	121.4	6.77	6.58	55.4	54.2
130.0	18.7	111.3	6.18	6.00	55.6	54.0
120.0	18.8	101.2	5.60	5.44	55.3	53.8
110.0	18.9	91.1	5.03	4.90	55.1	53.8
100.0	18.9	81.1	4.49	4.36	55.4	53.8
90.0	19.0	71.0	3.90	3.80	55.0	53.6
80.0	19.0	61.0	3.33	3.26	55.0	53.4
70.0	19.1	50.9	2.80	2.70	55.0	53.0

Average: 55.4 54.0

The thermocouples are calibrated together with the millivoltmeters (multiple reflection light spot type) with which they are to be used.

TABLE NO. C2.

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. C3.

ROTAMETER MAXIMUM FLOW RATE AND AIR DENSITY UNDER CALIBRATION CONDITIONS.

Orifice No.	Orifice Dia.	Test No.	Max.Flow Rate		Velocity in ½" probe		Air Density	
			ft^3/min.	litres/min.	ft/sec.	m/sec.	lbs/ft^3	kg/m^3
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/ft^3

or 760 mm.Hg, 21.1°C — 1.200 kg/m^3

At 760 mm.Hg, 0°C — 0.0807 lbs/ft^3, 1.293 kg/m^3

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

$Q_0 = 2.48$ ft^3/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 cm^2	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 ft^3 = 28.317 litres

1 kg/m^3 = 0.06243 lbs/ft^3

1 $gram/m^3$ = 0.4370 $grains/ft^3$

1 kg = 2.20462 lbs.

1 gram = 15.432 grains.

1 mm H_2O = 1 kg/m^2

1 m = 3.2808 ft.

1 cm^2 = 0.1550 in^2

TABLE NO. C4.

ORIFICE CALIBRATION.

ORIFICE NO. 1., $\frac{1}{4}$"

	Rotameter Reading	Correction	$\frac{1}{2}$" Probe: Velocity in Probe	$\frac{1}{2}$" Probe: Velocity Head p_v	Pressure drop across Orifice p_o	$\frac{3}{8}$" 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	
	30	0.1	2.93	0.450	5.91	1.471	Ratio of Velocity
	40	0.2	3.89	0.794	10.07	2.595	Head $\frac{3}{8}$" probe to $\frac{1}{2}$"
	50	0.3	4.87	1.245	15.21	4.069	probe.
	60	0.4	5.83	1.784	21.27	5.830	$\left(\frac{1.284}{0.955}\right)^4 = 3.268$
	70	0.5	6.80	2.427	28.11	7.931	
	80	0.7	7.75	3.153	36.07	10.30	$\gamma = 1.029$
	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, $\frac{1}{4}$".						
a	20	0	2.01	0.209	2.65	0.670	
	30	0.1	3,01	0.468	5.56	1.500	Ratio of Velocity
	40	0.2	4,00	0.827	9.84	2.651	Head $\frac{3}{8}$" probe to $\frac{1}{2}$"
	50	0.3	5.00	1.293	15.42	4.144	probe.
	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	$\gamma = 1.019$
	60	0.4	5.98	1.860	21.48	5.961	
	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	

FIGURE 1a.

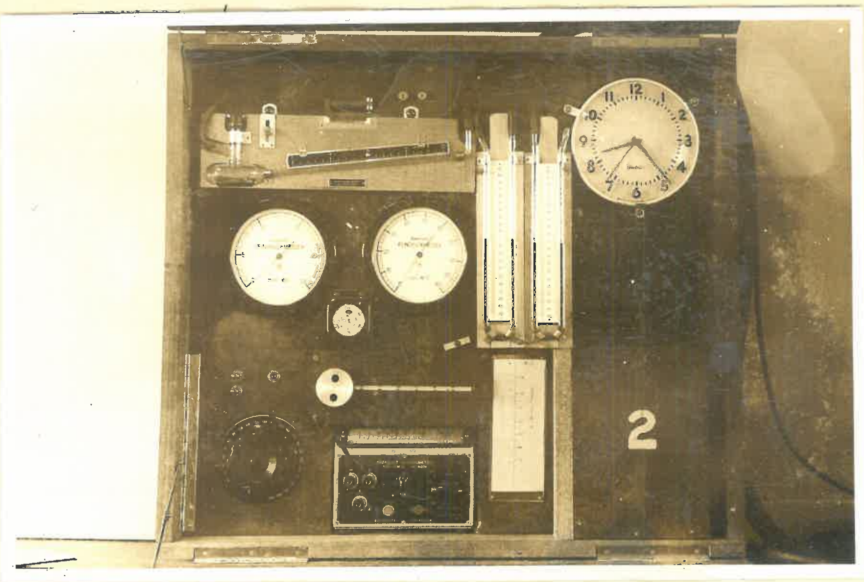


FIGURE 1b.

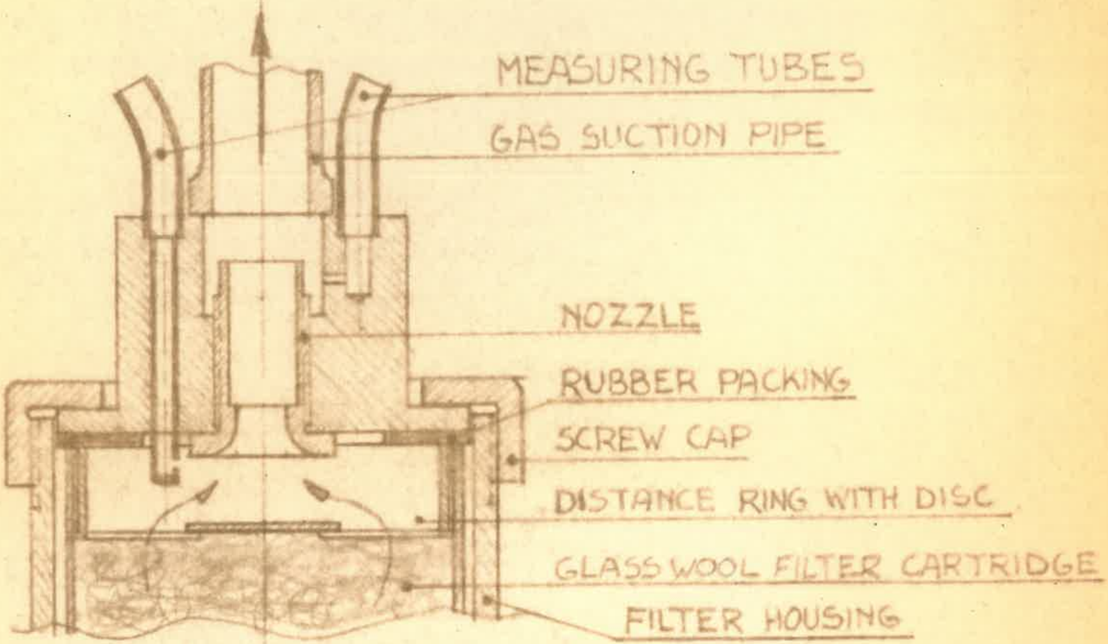
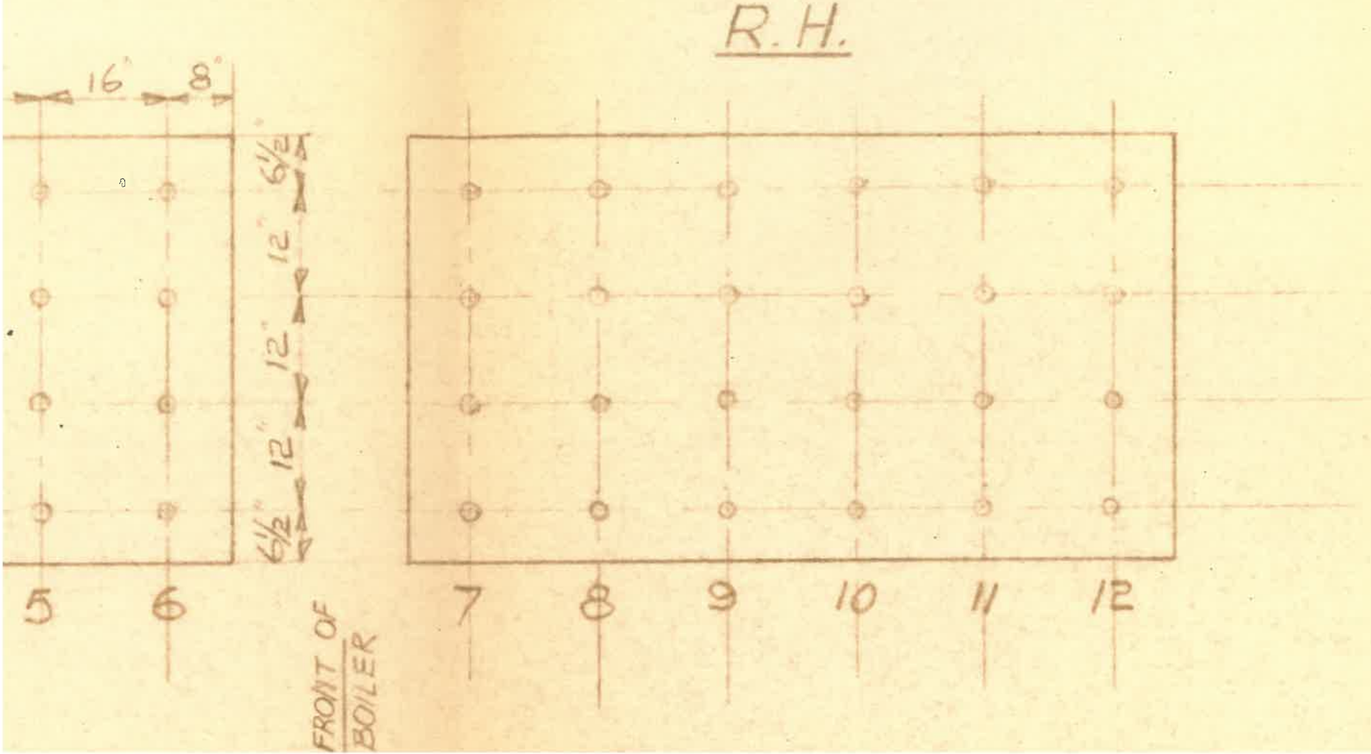
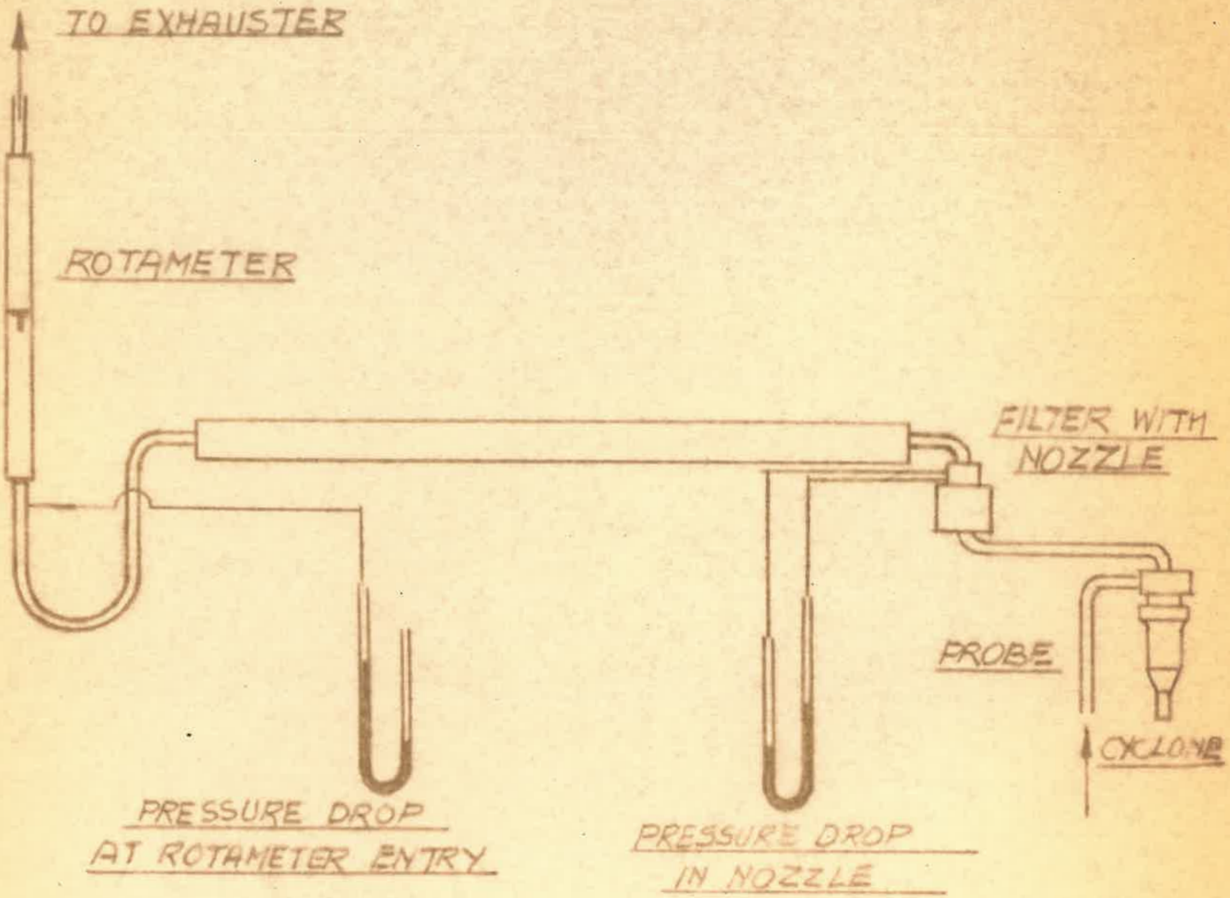


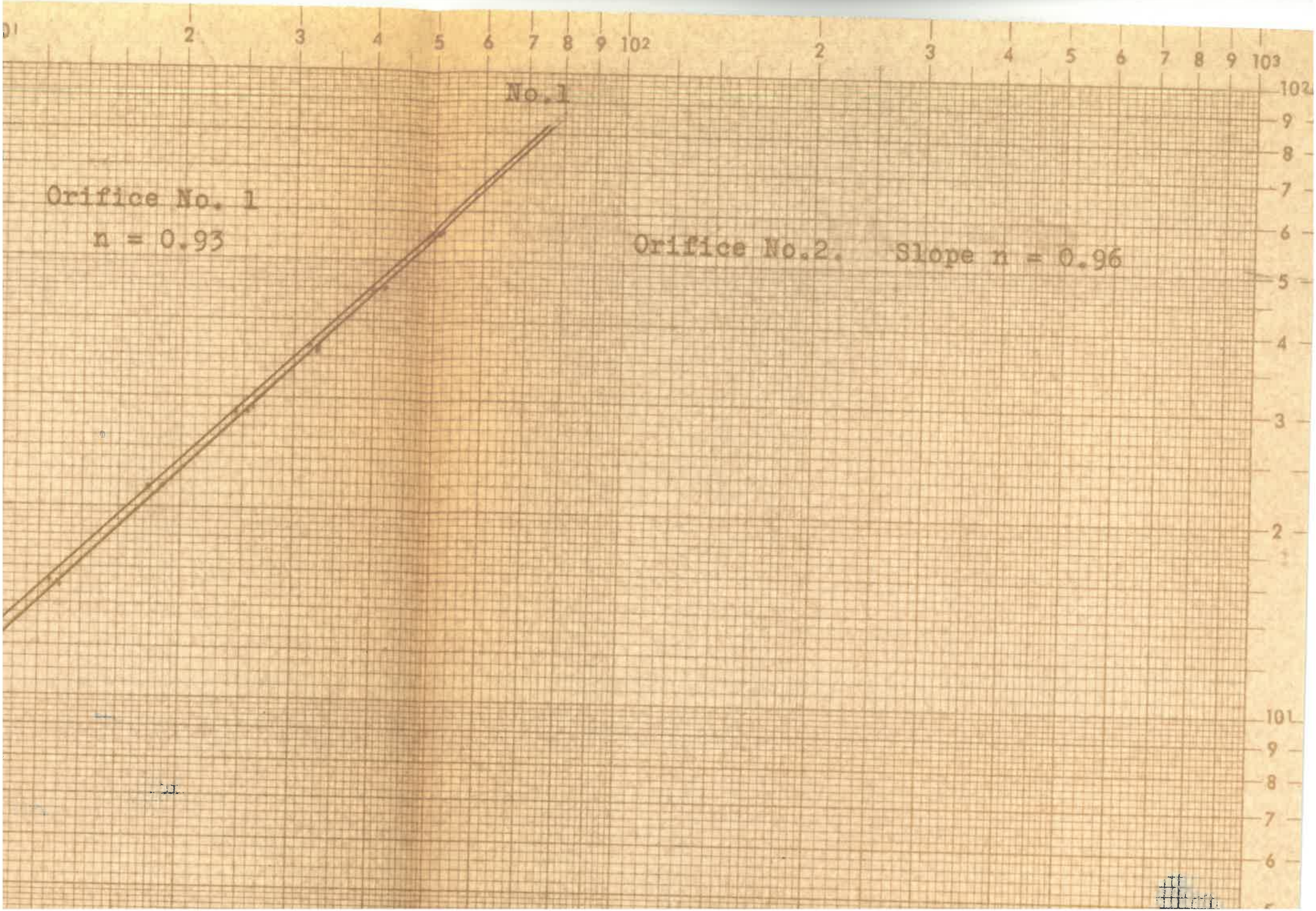
FIG. 2

FILTER HEAD AND NOZZLE



R.H.
16"
8"
6½"
12"
12"
12"
6½"
5
6
7
8
9
10
11
12
FRONT OF
BOILER


TO EXHAUSTER
ROTAMETER
FILTER WITH
NOZZLE
PROBE
CYCLONE
PRESSURE DROP
AT ROTAMETER ENTRY
PRESSURE DROP
IN NOZZLE


No. 1
Orifice No. 1
n = 0.93
Orifice No.2.
Slope n = 0.96

To this effect, the I.C.L. dust discharge valves were (of which three were installed on the primary, and three on the secondary collectors) were removed. Temporary pipes were run from the collector outlets to within a few feet of the firing floor. Davidson dust valves were fitted to the end of each of the six pipes.

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

The bins were weighed every 15 minutes and a sample of approx ½ lbs taken from each bin. All 3 primary samples were combined, the as well as the 3 secondary increments, as it was agreed that little purpose would be served in separating ~~taking~~ all six samples ~~separately~~.