FUEL RESEARCH INSTITUTE OF SOUTH AFRICA.

TECHNICAL MEMORANDUM NO. 42 OF 1965.

COMBUSTION TRIALS ON ANTHRACITES OF VARIOUS ASH CONTENT.

by:

G.S. VAN EEDEN

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1. PURPOSE OF INVESTIGATION.

The purpose of these tests was to assess whether anthracites of high ash content (e.g. washery middlings or discards) could be used as a low-cost smokeless domestic fuel.

A number of these products was subjected to a few types of combustion tests and the results compared with those obtained from the washed product which was tested in the same manner.* The particulars of the ash contents of the anthracites tested are given in Table No. 1.

2. DESCRIPTION OF TESTS.

Two combustion tests were applied viz.

(a) A test according to the British Standard B.S. 3142 : 1959.

(b) A Brazier test.

It may be noted that this standard specification is primarily intended for gas works coke, a more reactive fuel than anthracite.

2.1 In the first test the fuel is burnt in a Fulham Mark II open fire, as required by the specification. The grate is charged with 0.4 cubic feet of the fuel which is ignited by a gas burner. Gas is supplied at such a rate that 0.25 therms per hour are generated, with the total heat generated being limited to 7000 B.th.u. If no ignition occurs, the test is considered to be a failure, acoording to the standard. Where this was the case, ignition by other means - more gas, or wood - was used instead of gas.

During ...../

* In this connection see also Technical Memorandum No. 40 of 1965.

During the test the radiation in a specified direction, the total radiation and the density of the smoke generated were measured.

According to the standard specification, the radiant output in the specified direction must be at least 200 B.th.u./ft^2/hour after one hour. However, few South African fuels meet this requirement and moderate departures from this limit is considered to be acceptable.

2.2 The brazier test was developed to ascertain whether the fuels would be suitable for use in open braziers and the perforated drums frequently used by the urban Bantu.

The fuel (0.8 cub. ft.) was charged into the apparatus illustrated in figures 11 and 12 and a radiometer cage placed in the position as indicated. In this manner comparative data on heat output could be obtained. Since no suitable method for the measurement of the smoke density could be devised, this was not measured.

The fire was started by kindling 1 Kg. of wood plus 100 gm. of woodwool.

3. THE FUELS.

Anthracite from the following collieries was investigated:

(a) Natal Anthracite
(b) Natal Ammonium
(c) Alpha Anthracite*

Samples both of the raw coal fed to the washing plants at the colliery, and the washery discards were received.

From the feeds, fractions floating at a S.G. of 1.45 and in the range 1.45 to 1.60 were prepared at the institute. The discards were floated at 1.60.

Table No. 1 gives particulars of the various products.

4. ...../

* Alpha discards were not received. Some combustion tests were, however, performed earlier on an old sample of discards. This sample was, however, no longer available for the brazier test or analysis. The quantity of Alpha Anthracite F.1.45 - 1.60 was only sufficient for one test in the Fulham grate.

4. TEST RESULTS.

(a) Tests in Fulham Fireplace.

The radiation and smoke density curves are illustrated in figures 1 - 6, while figures 7 and 8 gives summarised data.

As might be expected, the ignition time increases with the increasing ash content of the fuel. The figures for the float 1.45 anthracites are quite good, but increase appreciably for the middlings. In practice this drawback may be overcome by using more kindling material, which, however, increases the cost for the user and tends to increase the smoke generated.

The heat output decreases with increasing ash content.

Smoke generation was negligible and confined to the ignition period. It may be noted that the Alpha washery discard sample, kindled with wood, produced rather more smoke initially, this probably being caused by the wood. Ignition with gas could not be achieved.

(b) Brazier tests.

Comparative heat generation figures are given in figure 9 and it is seen that all fuels are capable of generating an appreciable amount of radiant heat.

The initial smoke production, mainly caused by the kindling material, is, however, appreciable.

Some comparative data are shown in figure 10.

5. GENERAL CONCLUSIONS.

The middlings and discards are more difficult to ignite and burn slower than the low-ash product.

If, however, a generous amount of kindling material is used, as in the drum, all products perform in practically the same manner. This procedure is, however, more expensive and produces more smoke and the object of providing a cheap smokeless fuel is thus to some extent defeated.

G.S. VAN EEDEN
TECHNICAL OFFICER.

PRETORIA.
13th October, 1965.

TABLE NO. 1.

ANTHRACITE FOR COMBUSTION TESTS.

DATA ON ASH AND VOLATILE MATTER CONTENT.

54/65. NATAL ANTHRACITE.

+20 mm. FEED. A

S.G.	YIELD		ASH	
	FRACT. %	CUM. %	FRACT. %	CUM. %
F.1.40	50.87	50.87	6.2	6.2
1.40 - 1.45	29.74	80.61	9.5	7.42
1.45 - 1.50	7.30	87.91	15.6	8.10
1.50 - 1.55	4.00	91.91	20.6	8.64
1.55 - 1.60	1.86	93.77	27.8	9.02
S.1.60	6.23		59.5	
Whole Coal	100.00	100.00		12.16

F.1.45 - 1.60 Ash 18.84%

55/65. ALPHA ANTHRACITE.

+20 mm. FEED. B

S.G.	YIELD		ASH	
	FRACT. %	CUM. %	FRACT. %	CUM. %
F.1.40	59.68	59.68	7.2	7.2
1.40 - 1.45	8.27	67.95	12.2	7.81
1.45 - 1.50	3.94	71.89	18.5	8.40
1.50 - 1.55	3.50	75.39	23.6	9.11
1.55 - 1.60	3.05	78.44	28.7	9.87
S.1.60	21.56		61.0	
Whole Coal	100.00	100.00	-	20.89

F.1.45 - 1.60 Ash 23.17%

TABLE NO. 1 (Continued).

56/65. NATAL ANTHRACITE.
+20 mm. WASHERY DISCARD. C

S.G.	YIELD		ASH	
	FRACT. %	CUM. %	FRACT. %	CUM. %
F.1.40	0.21	0.21	7.4	7.4
1.40 - 1.45	0.15	0.36	11.9	9.28
1.45 - 1.50	1.32	1.68	18.7	16.68
1.50 - 1.55	9.66	11.33	23.6	22.59
1.55 - 1.60	16.31	27.64	29.4	26.61
S.1.60	72.36		61.5	
Whole Coal	100.00	100.00	-	51.86

58/65. NATAL AMMONIUM.
+20 mm. FEED. D

S.G.	YIELD		ASH	
	FRACT. %	CUM. %	FRACT. %	CUM. %
F.1.40	42.60	42.60	6.6	6.6
1.40 - 1.45	32.59	75.19	11.2	8.59
1.45 - 1.50	13.16	88.35	16.5	9.77
1.50 - 1.55	3.80	92.15	21.1	10.24
1.55 - 1.60	1.84	93.99	26.9	10.56
S.1.60	6.01		55.4	
Whole Coal	100.00	100.00	-	13.26

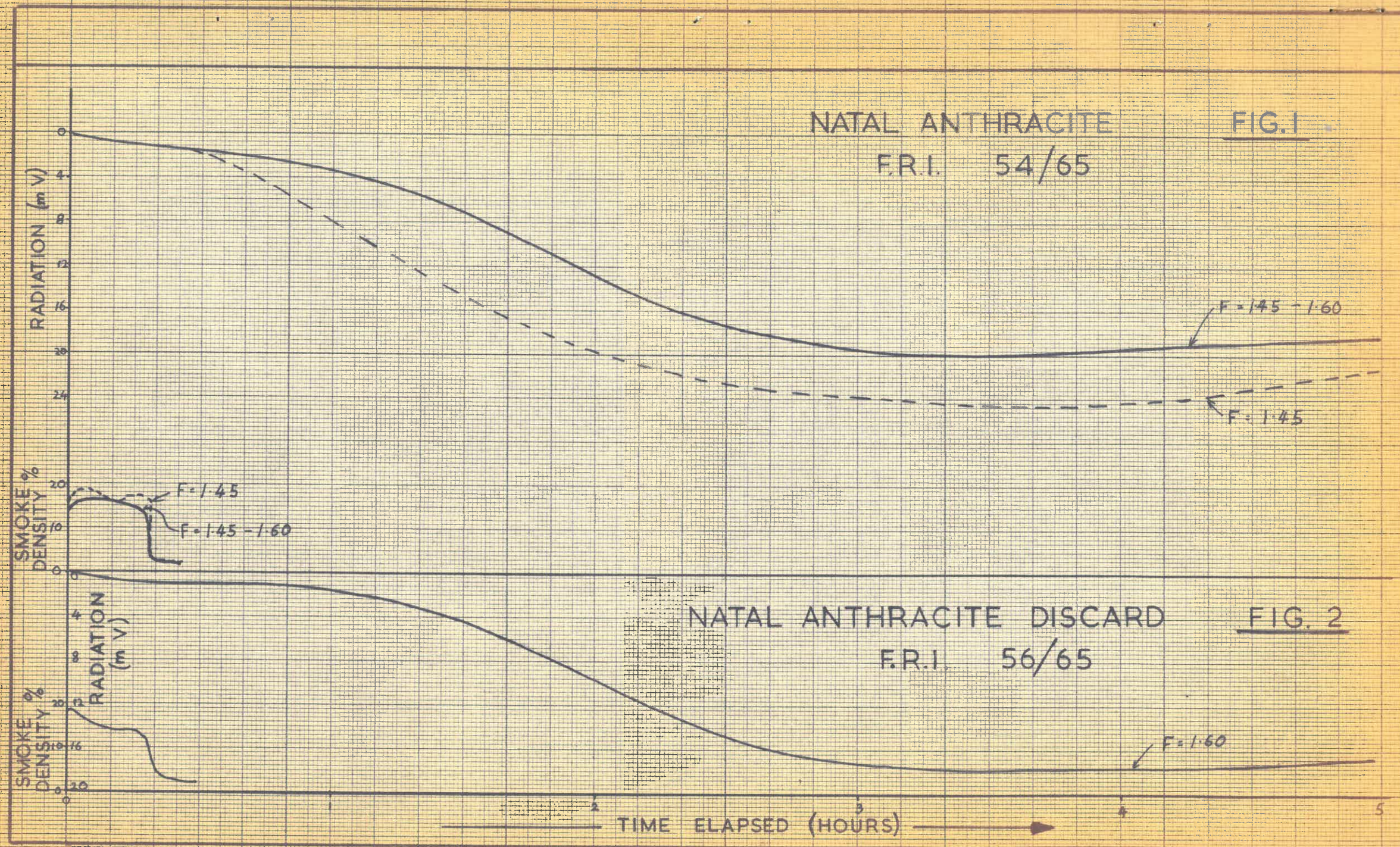
F.1.45 - 1.60 Ash 18.45%

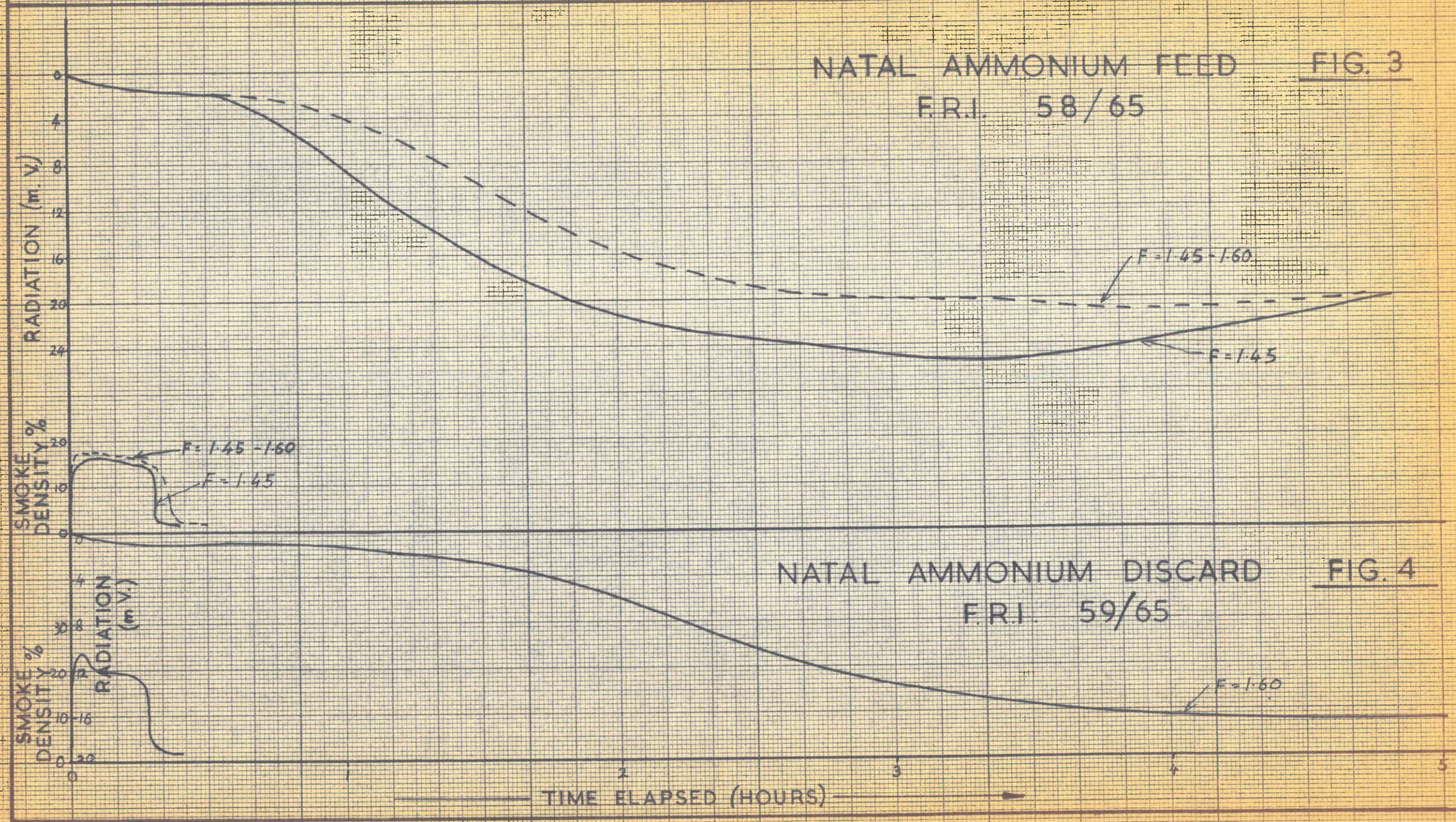
59/65. NATAL AMMONIUM.
+20 mm. WASHERY DISCARD. E

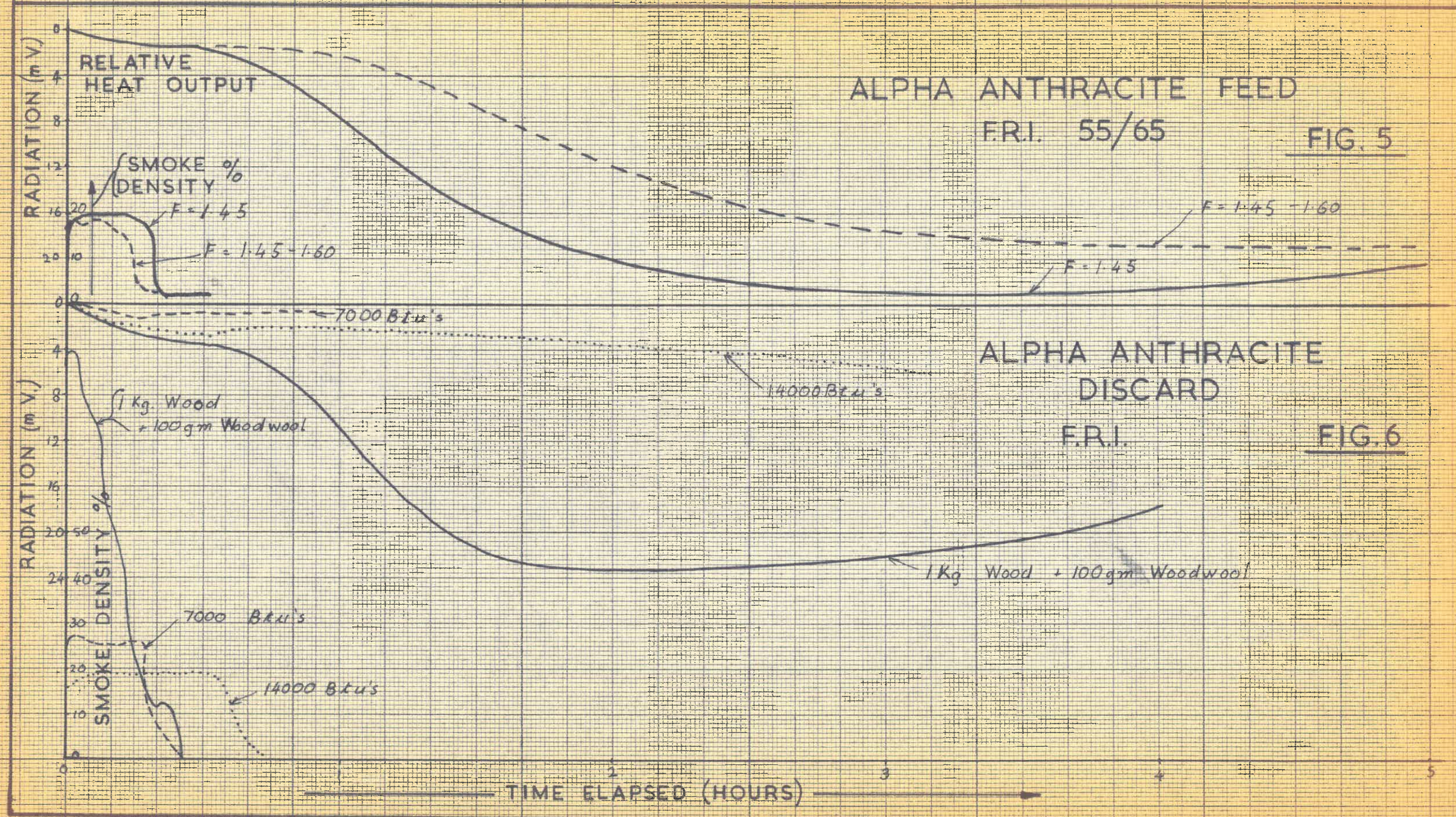
S.G.	YIELD		ASH	
	FRACT. %	CUM. %	FRACT. %	CUM. %
F.1.40	5.99	5.99	7.2	7.2
1.40 - 1.45	13.71	19.70	12.7	11.03
1.45 - 1.50	36.10	55.80	16.9	14.83
1.50 - 1.55	12.53	68.33	21.4	16.03
1.55 - 1.60	9.67	78.00	28.3	17.59
S.1.60	22.00		55.7	
Whole Coal	100.00	100.00	-	25.97

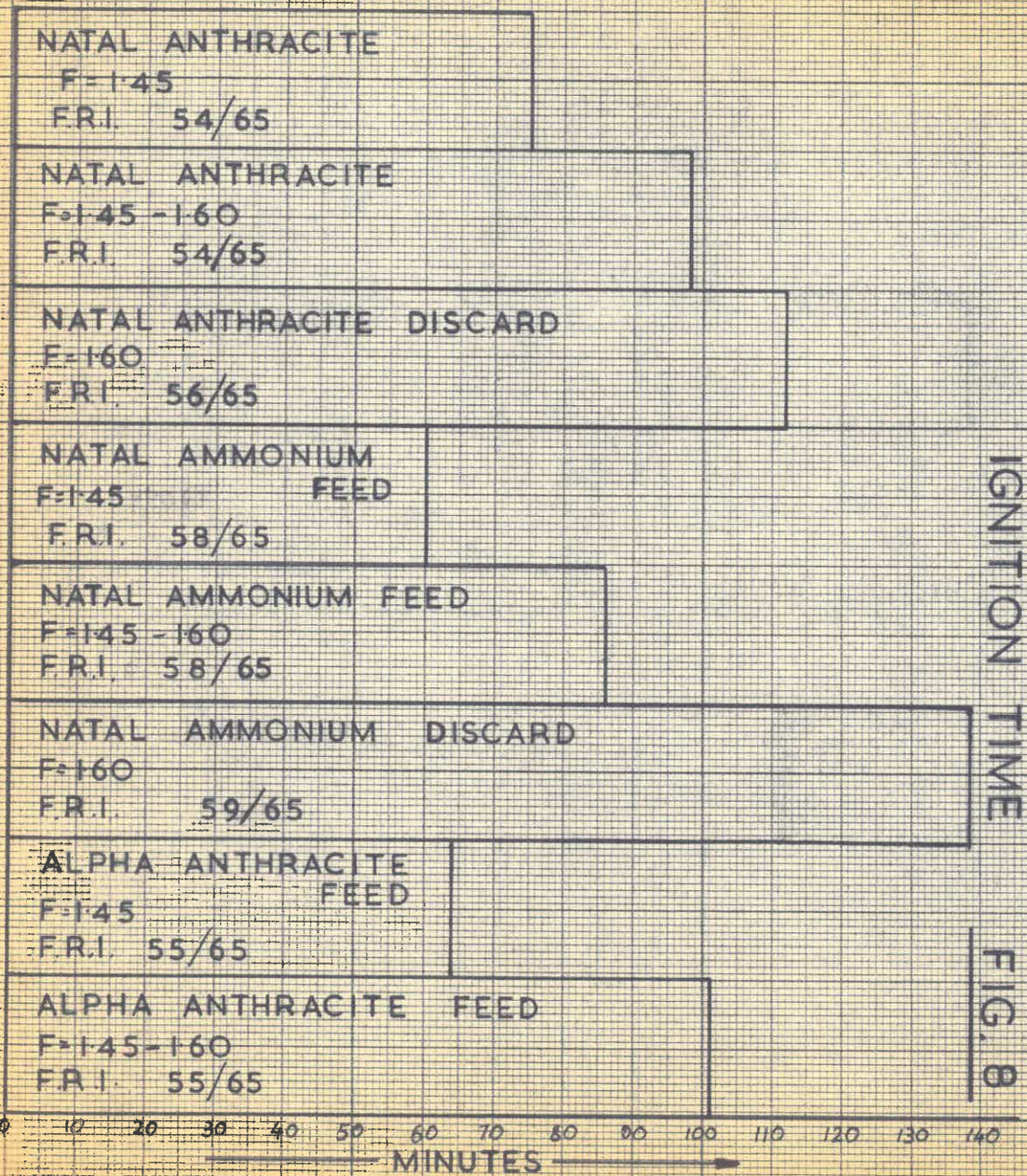
PROXIMATE ANALYSIS OF FUELS.

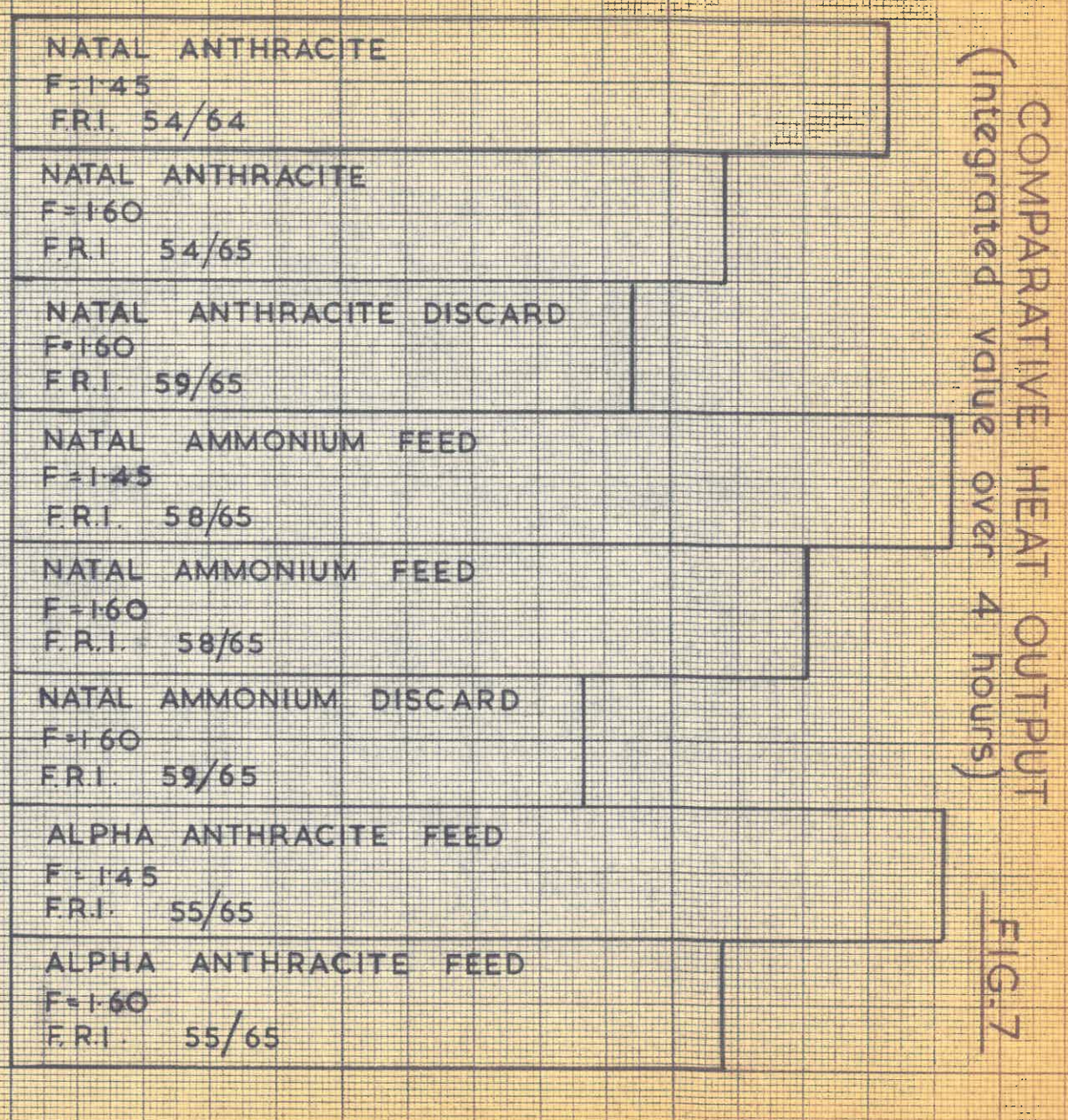
FUEL	REF. NO.	H_2O	ASH	V.M.	FIXED C.
NATAL ANTHR. F.1.45	54/65	1.1	8.0	10.2	80.7
NATAL ANTHR. F.1.45 - 1.60	54/65	Quantity barely sufficient for combustion tests			
NATAL ANTHR. DISC. F.1.60	56/65	1.0	26.7	8.7	63.6
NATAL AMMON. F.1.45	58/65	1.1	8.8	10.6	79.5
NATAL AMMON. F.1.45 - 1.60	58/65	1.0	19.3	9.7	70.0
NATAL AMMON. DISC. F.1.60	59/65	1.4	17.4	9.0	72.2
ALPHA ANTHR. F.1.45	55/65	1.0	8.1	10.0	80.9
ALPHA ANTHR. F.1.45 - 1.60	55/65	Not sufficient material available			
ALPHA ANTHR. DISCARD	Sample no longer available				


NATAL ANTHRACITE
F.R.I. 54/65
FIG.1
RADIATION (m V)
SMOKE % DENSITY
F = 1·45 - 1·60
F = 1·45
NATAL ANTHRACITE DISCARD
F.R.I. 56/65
FIG. 2
RADIATION (m V)
SMOKE % DENSITY
F = 1·60
TIME ELAPSED (HOURS)


NATAL AMMONIUM FEED
F.R.I. 58/65
FIG. 3
SMOKE DENSITY %
RADIATION (m. V.)
0
4
8
12
16
20
24
F = 1·45 - 1·60
F = 1·45
NATAL AMMONIUM DISCARD
F.R.I. 59/65
FIG. 4
SMOKE DENSITY %
RADIATION (m V)
0
4
8
12
16
20
24
28
32
F = 1·60
0
1
2
3
4
5
TIME ELAPSED (HOURS)


RADIATION (e.V.)
RELATIVE HEAT OUTPUT
SMOKE % DENSITY
F = 1·45
F = 1·45 - 1·60
7000 Btu's
14000 Btu's
1 Kg. Wood + 100gm Woodwool
TIME ELAPSED (HOURS)
ALPHA ANTHRACITE FEED
F.R.I. 55/65
FIG. 5
ALPHA ANTHRACITE DISCARD
F.R.I.
FIG. 6


NATAL ANTHRACITE
F=1·45
F.R.I. 54/65
NATAL ANTHRACITE
F=1·45 - 1·60
F.R.I. 54/65
NATAL ANTHRACITE DISCARD
F=1·60
F.R.I. 56/65
NATAL AMMONIUM FEED
F=1·45
F.R.I. 58/65
NATAL AMMONIUM FEED
F=1·45 - 1·60
F.R.I. 58/65
NATAL AMMONIUM DISCARD
F=1·60
F.R.I. 59/65
ALPHA ANTHRACITE FEED
F=1·45
F.R.I. 55/65
ALPHA ANTHRACITE FEED
F=1·45-1·60
F.R.I. 55/65
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140
MINUTES
IGNITION TIME
FIG. 8


NATAL ANTHRACITE
F=1·45
F.R.I. 54/64
NATAL ANTHRACITE
F=1·60
F.R.I. 54/65
NATAL ANTHRACITE DISCARD
F=1·60
F.R.I. 59/65
NATAL AMMONIUM FEED
F=1·45
F.R.I. 58/65
NATAL AMMONIUM FEED
F=1·60
F.R.I. 58/65
NATAL AMMONIUM DISCARD
F=1·60
F.R.I. 59/65
ALPHA ANTHRACITE FEED
F=1·45
F.R.I. 55/65
ALPHA ANTHRACITE FEED
F=1·60
F.R.I. 55/65
COMPARATIVE HEAT OUTPUT
(integrated value over 4 hours)
FIG. 7

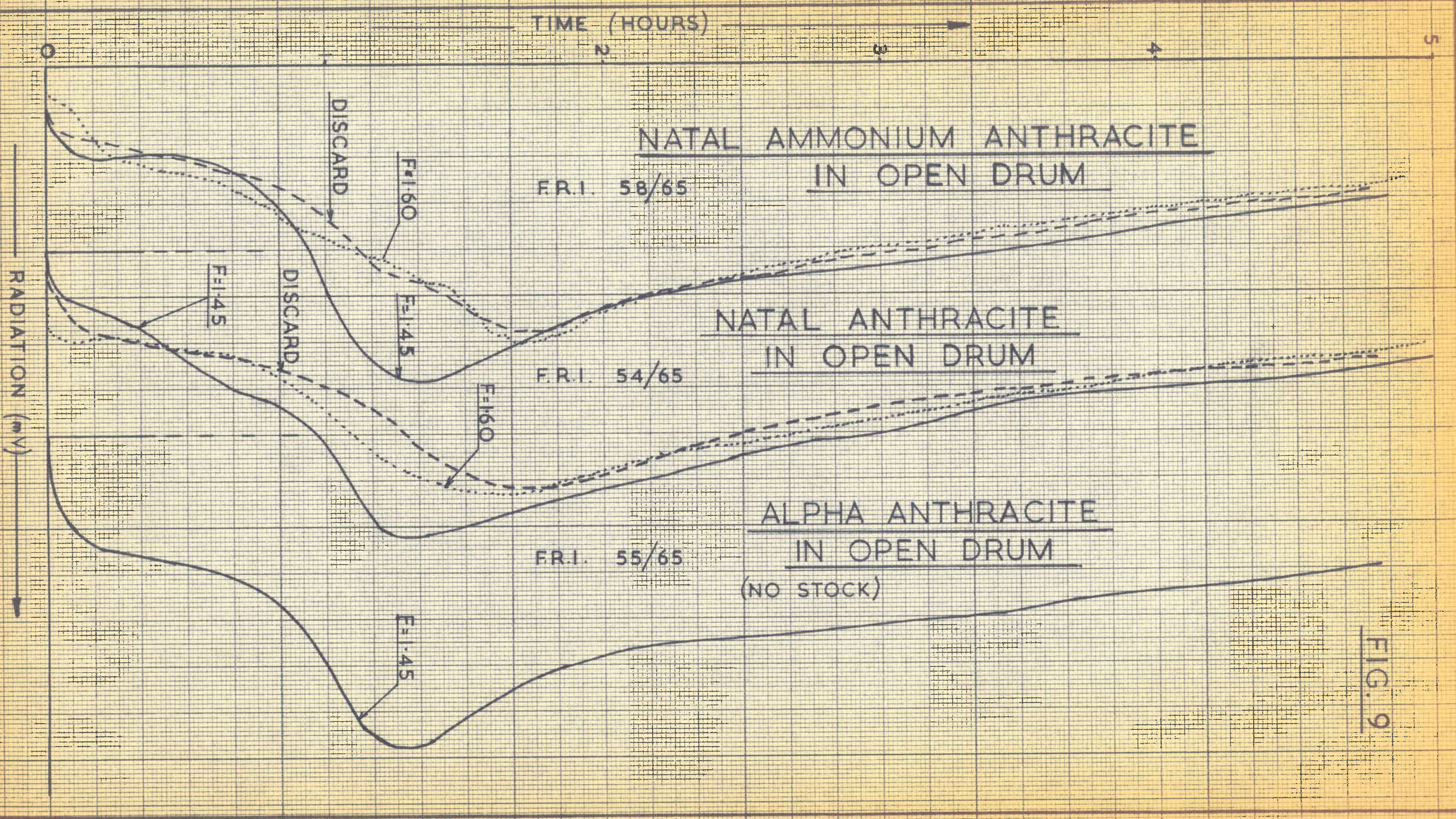
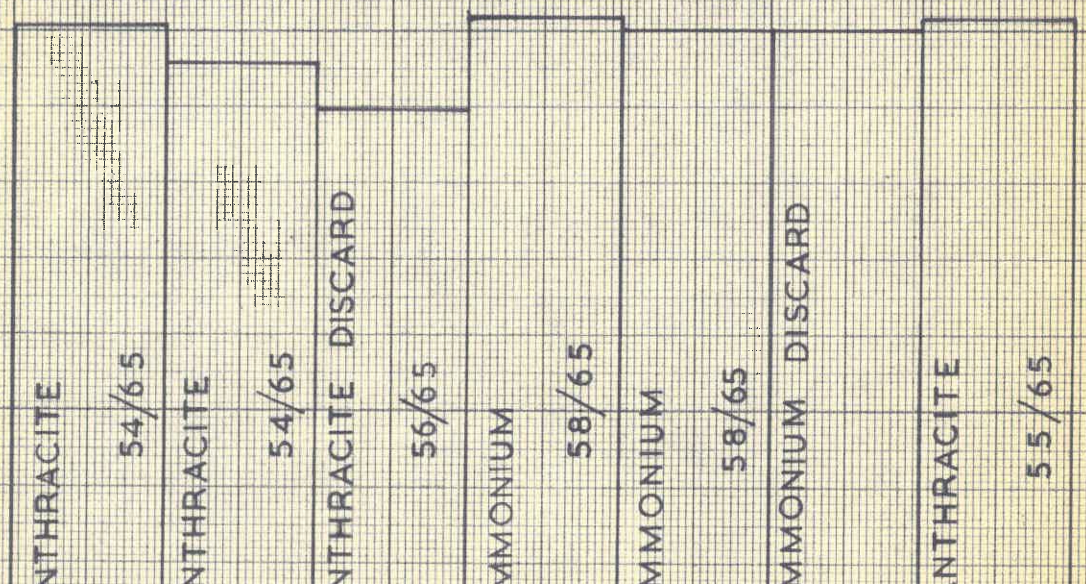

TIME (HOURS)
0
1
2
3
4
5
RADIATION (mV)
NATAL AMMONIUM ANTHRACITE
IN OPEN DRUM
F.R.I. 58/65
NATAL ANTHRACITE
IN OPEN DRUM
F.R.I. 54/65
ALPHA ANTHRACITE
IN OPEN DRUM
(NO STOCK)
F.R.I. 55/65
DISCARD
F=1·60
F=1·45
F=1·45
DISCARD
F=1·60
F=1·45

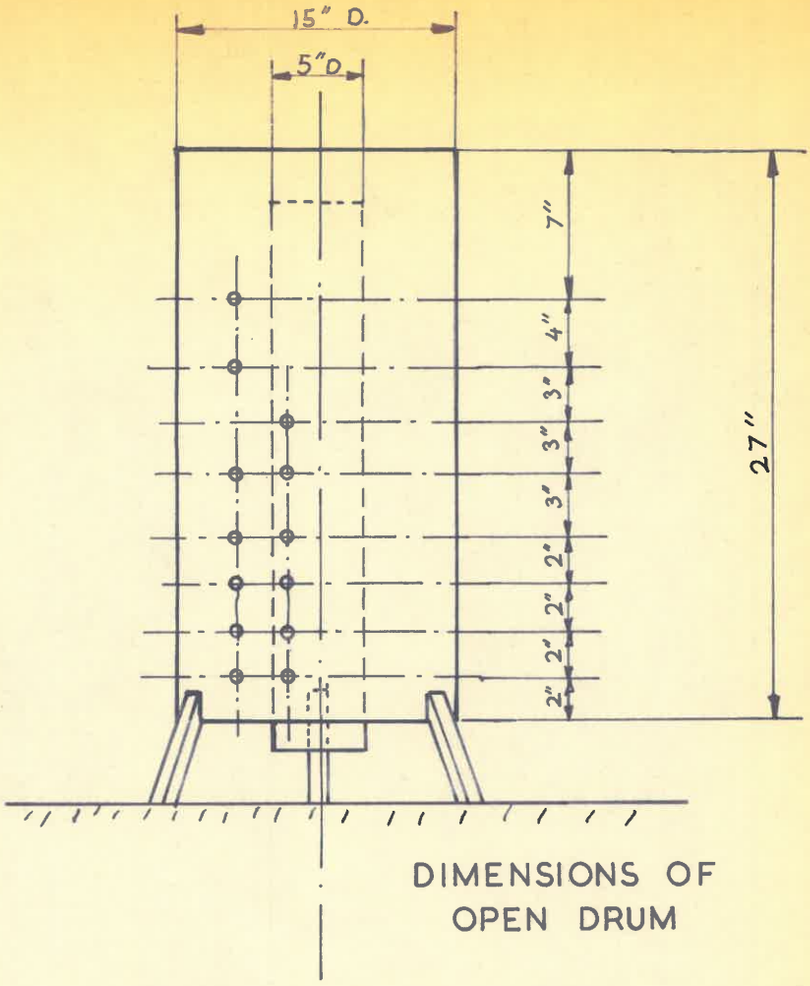
FIG. 9

FIG. 10

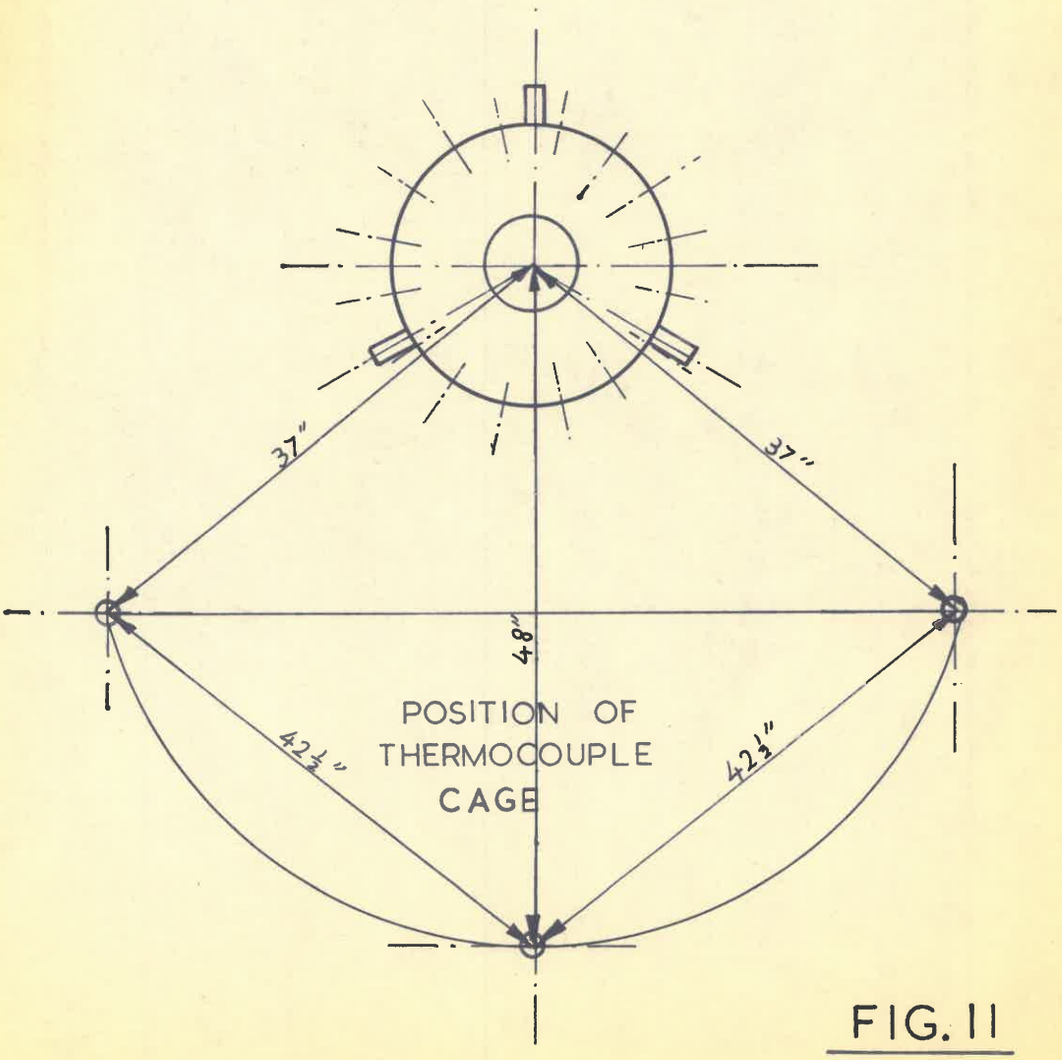
COMPARATIVE HEAT OUTPUT

BRAZIER TEST





DIMENSIONS OF
OPEN DRUM



POSITION OF
THERMOCOUPLE
CAGE

FIG. 11