CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES

CANADA CENTRE FOR MINERAL AND ENERGY TECHNOLOGY

OTTAWA

Energy Research Laboratories
Divisional Report ERL 75/36-CCRL

BOILER ACCEPTANCE TESTS

CENTRAL HEATING PLANT, CFB OTTAWA NORTH

ROCKLIFFE, ONTARIO

JANUARY 14-15, 1975

by

A.C.S. Hayden and R.G. Fouhse

March 1975



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INTRODUCTION

At the request of G. MacDonald, Utilities Officer, CFB Ottawa-North, Department of National Defence, staff of the Canadian Combustion Research Laboratory conducted performance tests on Boiler Number 2 of the Central Heating Plant of CFB Ottawa North. This boiler had originally been stoker-fired and had been converted to be fired by either No. 4 fuel oil or natural gas. The purpose of the tests was to measure the performance of the new firing systems with respect to contract specifications.

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DESCRIPTION OF EQUIPMENT

The Central Heating Plant of CFB Ottawa North is equipped with four watertube boilers, numbered 1 to 4. Details of manufacturer and ratings are as follows:

Boiler No. 1: John Inglis 400 HP

Boiler No. 2: Foster Wheeler 3100 lbs of steam/hr

Boiler No. 3 and No. 4: Waterous 3100 lbs of steam/hr

The boiler layout with the numbering system as used for the tests is shown in Figure 1.

Boilers No. 1, 3 and 4 are equipped with Peabody Compower steam atomizing oil burners and natural gas burners. Boiler No. 2, on which these tests were carried out, is equipped with a Todd steam atomizing oil burner, designed to burn fuel oil not heavier than No. 2, and a natural gas burner. Details of the equipment are presented in Appendix A.

Automatic control is provided by a Bailey pneumatic system, with air as the master. For each boiler, steam flow is measured, recorded and integrated by an orifice meter and oil flow is monitored by an integrating displacement meter. A single integrating displacement meter measures the natural gas flow to the Plant.

FUEL ANALYSIS

A sample of the fuel oil was taken by CCRL staff during the tests and submitted for analysis to the Petroleum and Gas Laboratory of the Energy Research Laboratories, Canada Centre for Mineral and Energy Technology (CANMET), Department of Energy, Mines and Resources, Ottawa. The results are shown in in Table 1.

The gas supplier, Trans Canada Pipelines Ltd., provided a representative analysis of the natural gas as burned during the tests. This analysis is presented in Table 2.

DESCRIPTION OF TESTS AND RESULTS

Because the contract chiefly involved conversion of the firing equipment to both oil and natural gas firing, the tests were primarily aimed at evaluating boiler performance, but they were also intended to measure overall burner efficiency, to determine the nature of any operational limitations and to establish whether or not the automatic controls were suitably calibrated. For the test, the master-air control was held on manual to obtain the desired load conditions. The fuel flow was allowed to follow on automatic control, in order that the tests would duplicate actual boiler performance conditions. All tests were conducted under stabilized conditions, at loads roughly corresponding to 20%, 66% and 100% of the maximum continuous rating of the boiler. Conditions governing the load and excess air settings, as well as comments on the flame obtained, are summarized in Table 3, for each test.

During the tests, operating data were recorded at fifteen minute intervals, using the Plant instruments, with the following exceptions. Flue gas was monitored continuously by means of infra-red analyzers for CO₂ and CO and a paramagnetic analyzer for oxygen. As a check on the Plant instruments, flue gas temperature was measured with a chromel-alumel, multi-junction averaging thermocouple and a portable potentiometer. The temperatures of the combustion air and the ambient air were measured with mercury thermometers.

The average data recorded for each test, along with the calculated results, are presented in Table 4. Tables 5 to 11 show the heat balances and calculations for tests 1 to 7, respectively, in the ASME Short Form format. Figure 2 presents the efficiency curves for the boiler, for both oil and natural gas firing. On oil firing, the efficiencies average about 82% and on natural gas firing, 78%.

After the constant load tests for each fuel, the boiler was allowed to run from low fire to full load on automatic in a very short period of time (less than ten minutes). On gas firing no problem occurred. However, on oil firing, when the boiler reached full load, the firing rate began to hunt, and the burner cut out. It was found that the governing cam had been cut in such a way that it had a lip at the top end, and once this point was exceeded, the

burner could not return to a lower firing rate. The contractor was made aware of this defect and, before CCRL staff left, reset stops on the controls to prevent this point from being reached. The actual load where this occured was at a somewhat higher firing rate than the full load test conducted by CCRL, so that the test results apply completely.

DISCUSSION AND CONCLUSIONS

The converted boiler offers consistently good performance on both oil and gas firing. In particular, the performance on oil firing can be considered to be somewhat above average for this type of equipment.

The boiler pressure meter located on the main panel should be recalibrated, as it is consistently reading some 5 psig low. Similarly, the flue gas temperature sensing and recording device should be checked, as it is grossly in error on the low side.

It is recommended that serious consideration be given to the purchase of an oxygen monitoring instrument to measure the oxygen concentration in the flue gas. This, in conjunction with accurate flue gas temperature measurements, can give a rapid determination of boiler efficiency. In particular, paramagnetic oxygen analyzers have been found by CCRL staff to give the best results.

From time to time, checks by Plant staff should be performed on the boiler to ensure that the stops set up by the contractor that firing rate can not increase beyond the smooth region of the burner control cam, where return to lower firing is impossible, as described previously.

In conclusion, it appears that the conversion of these boilers has been carried out in accordance with good industrial practice. The burners themselves are robust in design, provide good control over the flame shape, have an acceptable turn-down ratio, and result in satisfactory boiler efficiencies.

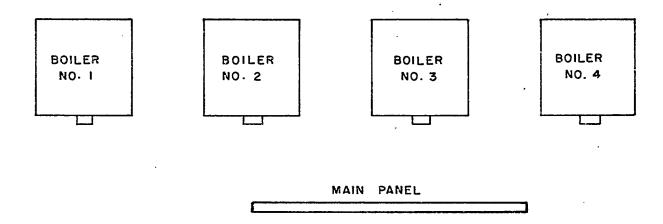


Figure 1. Boiler layout, CFB Ottawa North CHP

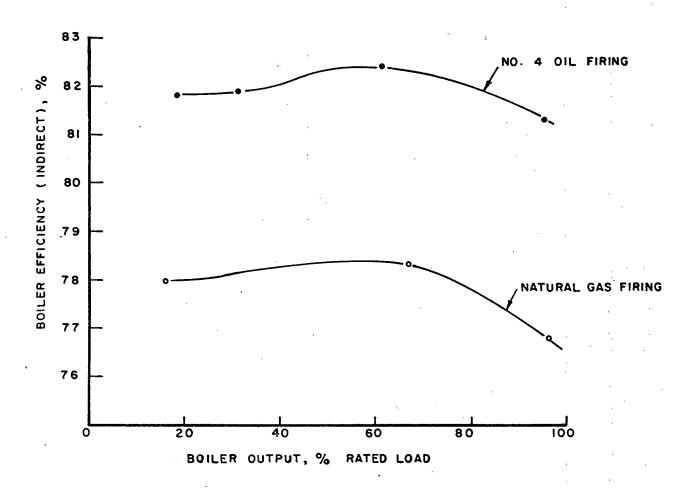


Figure 2. Boiler indirect efficiency versus output, Boiler No.2, CFB Ottawa North CHP

TABLE 1

Analysis $\frac{1}{}$ of No. 4 Fuel Oil - CFB Ottawa North

Date:	January 15, 1975
Sample Number:	A004-75; 21-75
Specific Gravity, 60/60°F:	0.898
Viscosity at 122°F, cst:	10.21
Heat of Combustion, Btu/1b:	20,432
Carbon, % by weight:	86.37
Hydrogen, "	12.36
Nitrogen, "	0.11
Sulphur, "	1.14
Vanadium, ppm by weight:	107

^{1/}Analysis performed by the Petroleum and Gas Laboratory, Energy Research Laboratories, Canada Centre for Mineral and Energy Technology, Department of Energy, Mines and Resources, Ottawa.

TABLE 2

Analysis of Na	tu r al	Gas	_	CFB	Ottawa	Nor th
Nitrogen, % by we	eight	:			2.	21
Carbon Dioxide,	11				0.	36
Methane,	11	•			93.	17
Ethane,	11			-	4.	14
Propane,	11				0.	15
Isobutane,	11				0.	01
N-butane,	11		*		0.	01
Total Sulphur, g	rains	/100	f	t ³ :	0.	15
Specific Gravity	, 60/	60 ⁰ F	:		0.	588
Heat of Combusti	on, B	tu/10	00	0 ft	³ : 10	06

Tontinuous analysis of natural gas supplied to Ottawa region by TransCanada Pipelines Ltd. over period January 13-17, 1975.

TABLE 3

Summery of Test Conditions and Operating Limitations - Boiler No. 2

- Test 1: 96% of rating. Natural gas firing. Air on manual, set at 100. Fuel on automatic. Good, clean, non luminous flame.
- Test 2: 61% of rating. Natural gas firing. Air on manual, set at 55.

 Fuel on automatic. Good, clean, non luminous flame with some yellow traces at 10 o'clock.
- Test 3: 16% of rating. Natural gas firing. Air on manual, set at 0. Fuel on automatic. Good flame with lazy yellow tips.
- Test 4: 96% of rating. No. 4 oil firing. Air on manual set at 100.

 Fuel on automatic. Good, bright flame with no snow. Stack clear.
- Test 5: 61% of rating. No. 4 oil firing. Air on manual, set at 55. Fuel on automatic. Good, bright flame. Stack clear.
- Test 6: 31% of rating. No. 4 oil firing. Air on manual, set at 20. Fuel on automatic. Good, bright flame with some lazy tips. Stack clear.
- Test 7: 18% of rating. No. 4 oil firing. Air on manual, set at 0. Fuel on automatic. Clean, lazy flame with little snow. Stack clear.

TABLE 4

Summary of Boiler Acceptance Test Data and Calculations - CFB Ottawa North - Boiler No. 2

Test No.	1	2	3	4	5	6	. 7
Fuel	Natural gas	Natural gas	Natural gas	No. 4 oil	No. 4 oil	No. 4 oil	No. 4 oil
Rated Capacity, k lb/hr	31	31	31	31	.31	31	31
Date	14/1/75	14/1/75	14/1/75	15/1/75	1 5/1/75	15/1/75	15/1/75
Test Duration, hr	1	1	1	. 1	1	.5	. 25
Steam Pressure, psig							
Drum, blr	132	130	125	126	124	121	121
Drum, panel	126	124	120	120	118	115	115
Header	126	126	125	120	120	120	120
Steam Flow, k lb/hr					•		
Indicated	29.0	20.6	4.9	30.1	19.7	9.9	5.3
Integrator	29.6	20.6	5.0	30.2	19.4	9.9	5.8
Corrected	29.75	20.70	5.0	29.60	19.01	9.70	5.68
% Rated Capacity	95.7	66.8	16.1	95.5	61.3	31.3	18.3
Air Flow, k lb/hr rel	28.0 .	20.0	5.1	28.6	20.6	12.9	6.4
Feedwater					•		
Temp., °F	. 216	216	217	217	202	204	212
Pressure, psig	165	168	170	160	161	166	166
Air Temperature, ^O F							
Ambient	74	75	75	72	74	7 5	7 5
Combustion	82	81	81	82	81	80	80
Flue Gas Temp., ^o F			•				
Panel	392	330	210	400	331	261	220
CCRL	607	517	353	633	535	· 435	370
F/D Control Setting	100	55	0	100	55	20	. 0
= , = 3-11-12			•			-	

(cont'd)

TABLE 4 (cont'd)

Summary of Boiler Acceptance Test Data and Calculations - CFB Ottawa North - Boiler No. 2

Test No.	1	2	3	4	5	6	7
Supply Gas					•		
Temp., OF	35	35	35				
Pressure, psig	3 7. 5	38.0	38.0		•		
Gas Flow,							
Timed, sec/100 ft ³	36.8	56.8	233			,	
Integrator, ft ³ /hr	97 83	6200	1600				
Gas Burner Press., psig	2.05	1.05	0.20				
il Flow				106	106	100	100
Temperature				106	. 106	106 49.49	106 92.2
Timed, sec/gal	0			16.73	25.15	72.8	39.1
Integrator, k 1b/hr x1	.0			215.2	143.4	12.0	37.1
Burner Press., psig		•					
Oil				78	58	34	22
Steam				95	77	51	37
Pressure, in. W.C.					•		
Windbox	6.1	2.6	0	5.9	2.4	0.4	0_
Furnace	0.6	-0.2	- 0.5	-0.5	-0.12	-0.5	-0.5
Upstake	-0.45	-0.55	-0.53	-0.39	-0.50	-0.55	-0.55
Flue Gas Analysis				•			
CO_2 , % by vol.	10.5	10.4	9.7	13.9	13.3	11.0	11.1
CO, "	.04	.03	.02	aprille	.03	.03	.03
02, "	1.93	1.93	3.60	2.51	3.50	6.0	5.8
Excess Air, %	8.85	8.87	18.26	12.61	18.52	36.79	35.07

(cont'd)

TABLE 4 (Cont'd)

Summary of Boiler Acceptance Test Data and Calculations - CFB Ottawa North - Boiler No. 2

Test No.	1	2	3	. 4	5	6	7
Total Heat Input, k Btu/hr		· •	- · · · · · · · · · · · · · · · · · · ·	43970	29290	14874	7989
Total Heat Output,k Btu/hr	30040	20890	5040	29837	19445	9899	5750
Direct Efficiency, %	<u>.</u> .	-	- .	67.86	66.39	66.55	71.97
Heat Balance (Losses)	*						
Dry gas loss, %	9.52	7.98	5.35	10.21	8.76	8.20	6.64
Hydrogen loss, %	12.23	11.83	11.11	7.09	6.84	6.59	6.42
CO loss, %	0.12	0.09	0.07		0.10	0.12	0.12
Radiation loss, %	0.90	1.30	5.00	0.90	1.40	2.70	4.50
Unmeasured losses, %	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Total losses, %	23.27	21.70	22.03	18.70	17.60	18.11	18.18
Indirect Efficiency, %	76.73	78.30	77.97	81.30	82.40	81.89	81.82

ASME TEST FORM FOR ABBREVIATED EFFICIENCY TEST

<u> </u>					TEST NO. 1	n	OIL E	r no. 2	DATE 1	4/1/75
OWN	ER OF PLANT DND					Ottawa			UAIE J	.4/1//3
	DILD	C To	ubaa		DBJECTIVE OF TEST	Accep			DUDATI	on 1 hr
	T CONDUCTED BY A.C.S. Hayden, R. LER, MAKE & TYPE Foster Wheeler	G. FO	unse		ABJECTIVE OF TEST				TY 31,000	
j	KER, TYPE & SIZE	···				K/	1120	CAPACI	77,000	TO/III
									M	
, I	VERIZER, TYPE & SIZE							R, TYPE	& SIZE To	dd
FUE	LUSED Natural Gas MINE PRESSURES & TEMPERATURES			COU	ҮТҮ	STATE			SIZE AS FI	RED
<u> </u>		γ	Τ	1	COAL AS FIRED	FUEL	T A	T		
 	STEAM PRESSURE IN BOILER DRUM	psia	146.7		PROX. ANALYSIS	% wt			OIL	
2	STEAM PRESSURE ATXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	psia	140.7	37	MOISTURE		51	FLASH	POINT F*	
3	STEAM PRESSURE AT R. H. INLET	psia		38	VOL MATTER		52	Sp. Grav	ity Deg. API*	
4	STEAM PRESSURE AT R. H. OUTLET			39	FIXED CARBON				TY AT SSU*	
1		psia		39	TIXED CARBON		53	BURNE	R SSF HYDROGEN	
5	STEAM TEMPERATURE AT S. H. OUTLET	F	 -	40	ASH	ļ	44	% wt		
6	STEAM TEMPERATURE AT R.H. INLET	F	 -		TOTAL		41	Btu per	lb	ļ
7	STEAM TEMPERATURE AT R.H. OUTLET	F		41	Btu per lb AS FIRED ASH SOFT TEMP.*		 			
8	WATER TEMP, ENTERING (基XXX) (BOILER)	F	216	42	ASTM METHOD				GAS	% VOL
9	STEAM QUALITY % MOISTURE OR P. P. M.				OAL OR OIL AS FIRED ULTIMATE ANALYSIS)	54	со		
10	AIR TEMP. AROUND BOILER (AMBIENT)	F	74	43	CARBON		55		METHANE	93.17
11	TEMP. AIR FOR COMBUSTION							 		4.14
12	(This is Reference Temperature) † TEMPERATURE OF FUEL	F	82	44	HYDROGEN		56	C ₂ H ₆		ļ
		ļ	35 607	45	OXYGEN		57	C ₃ H ₈		0.15
13	GAS TEMP, LEAVING (Boiler) (R欧双文松KKKX GAS TEMP, ENTERING AH (If conditions to be	F	007	46	NITROGEN		58	C4H10		0.02
	corrected to guarantee)	F	<u> </u>	47	SULPHUR		59	Nitro	gen	2.21
·	UNIT QUANTITIES	1	·	40	ASH		60	CO ₂		0.36
15	ENTHALPY OF SAT. LIQUID (TOTAL HEAT)	Btu/lb	1100 7	37	MOISTURE		61	<u> </u>		ļ
16	ENTHALPY OF (SATURATED) (发达京选税社CAX发放) STM.	Btu/lb	1193.7		TOTAL				TOTAL	100.0
	ENTHALPY OF SAT. FEED TO (BOILER)		184.1			·		TOTAL	HYDROGEN	
17	(太後後次)	Btu/Ib	104.1		COAL PULVERIZATION	 И		% wt		23.65
18	ENTHALPY OF REHEATED STEAM R.H. INLET	Btu/Ib		48	GRINDABILITY INDEX*		62	DENSIT	Y 68 F ATM. PRES	.588 s.
19	ENTHALPY OF REHEATED STEAM R. H.			49	FINENESS % THRU					1006
20	OUTLET HEAT ABS/LB OF STEAM (ITEM 16 ITEM 17)	Btu/lb	1000 (50	50 M* FINENESS % THRU		63 41		R CU FT	I
	TICK! ABS/EB OF STCAM (TCM TO = TCM 17)	510/15	1009.6	30	200 M*		41	Btu PE	R LB	22438
21	HEAT ABS/LB R.H. STEAM (ITEM 19-ITEM 18)	Btu/1b		64	INPUT-OUTPUT	T 0/	Ī	TEM 31 >		
22	DRY REFUSE (ASH PIT + FLY ASH) PER LB			\vdash	EFFICIENCY OF UNI	1 70		ITEM 2	Btu/lb	% of A. F.
	AS FIRED FUEL Biu PER LB IN REFUSE (WEIGHTED AVERAGE)	lb/lb	 	<u> </u>	HEAT LOSS EFFIC				A.F. FUEL	FUEL
23	CARBON BURNED PER LB AS FIRED FUEL	lb/lb	.7203	65 66	HEAT LOSS DUE TO		= 181 '		2135.70	9.52
25	DRY GAS PER LB AS FIRED FUEL BURNED	1b/1b	16.95	<u> </u>	HEAT LOSS DUE TO				27/2 76	12 22
1	HOURLY QUANTITIES	1 10/10	10.37	68	HEAT LOSS DUE TO			. J. J I П ₂	27.77	$\begin{array}{c} 12.23 \\ \hline 0.12 \end{array}$
26	ACTUAL WATER EVAPORATED	lb/hr	29750	69	HEAT LOSS DUE TO		N			0.90
27	REHEAT STEAM FLOW	lb/hr		70	UNMEASURED LOSSE	S				0.50
28	RATE OF FUEL FIRING (AS, FIRED wt)	lb/hr		71	TOTAL					23.27
29	TOTAL HEAT INPUT (Item 28 x Item 41)	kB/hr		72	EFFICIENCY = (100-	- Item 71)				76.73
30	1000 HEAT OUTPUT IN BLOW-DOWN WATER	kB/hr			AND DESCRIPTION OF THE PERSON					
	TOTAL (Itom 26×Itom 20)+(Itom 27×Itom 21)+Itom 30									
31	OUTPUT 1000	kB/hr	30040							
I	FLUE GAS ANAL. (BOILER) (ECON) (AIR HTR)	OUTLET	Γ				•			
32	ÇO₂	% VOL	10.5							
33	0,	% VOL	1.93				•			
34	CO (DV DIESEBENCE)	% VOL	. 04	,	* Nat Required for Effic	iency Test	ing			
35	N ₂ (BY DIFFERENCE)	% VOL	87.57 8.85		+ Eas Paint of H	.a C D	7·	00157	. 4.1.104.4	
30	EXCESS AIR	7,		l	t For Point of Measurem	ient See Po	ar. /,:	4,0,1-17 10	4.1-1904	

ASME TEST FORM FOR ABBREVIATED EFFICIENCY TEST

					TEST NO. 2	В	OILE	R NO. 2	DATE 1	4/1/75
OWN	ER OF PLANT DND	· - · · · · ·				Ottaw				17 -7 - 5
TES	T CONDUCTED BY A.C.S. Hayden, R	.G. F	ouhse	Ċ	BJECTIVE OF TEST	Accep	tan	ce	DURATIO	n 1 hr
	ER, MAKE & TYPE Foster Wheeler	,,							TY 31,000	
	KER, TYPE & SIZE						11-0	CAIACI	11, 31,000	10/111
	VERIZER, TYPE & SIZE						IDNE	R, TYPE	• cl75 TO	dd
t	LUSED Natural Gas MINE			COU	NTV	STATE		K, IIFE	D(312.L	
FUL	PRESSURES & TEMPERATURES			C00	NII	FUEL		ТА	SIZE AS FIF	(EU
	STEAM PRESSURE IN BOILER DRUM		144.7		COAL AS FIRED			1		
<u> </u>		psia			PROX. ANALYSIS	% wt	<u> </u>	ļ	OIL	1
2	STEAM PRESSURE A TXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	psia	138.7	37	MOISTURE		51	FLASH	POINT F*	·
3	STEAM PRESSURE AT R. H. INLET	psia		38	VOL MATTER		52	4	ity Deg. API*	
4	STEAM PRESSURE AT R. H. OUTLET	psia		39	FIXED CARBON		53	VISCOS BURNE	ITY AT SSU* R SSF	
								TOTAL	HYDROGEN	
5 6	STEAM TEMPERATURE AT S. H. OUTLET STEAM TEMPERATURE AT R. H. INLET	F F		40	TOTAL		44	% wt		
7	STEAM TEMPERATURE AT R.H. OUTLET	F		41	Btu per Ib AS FIRED		41	Btu per	ID	
	TEAM TEAM ENTINE AT INTI. 00 / 12 /			-7'-	ASH SOFT TEMP.*					
8	WATER TEMP, ENTERING (EXCONN) (BOILER)	F	216	42 C	ASTM METHOD OAL OR OIL AS FIRED		<u> </u>	1	GA S	% YOL
9	STEAM QUALITY % MOISTURE OR P. P. M.				ULTIMATE ANALYSIS	· 	54	со		
10	AIR TEMP. AROUND BOILER (AMBIENT)	F	7 5	43	CARBON		55	CH₄ A	AETHAN E	93.17
11	TEMP. AIR FOR COMBUSTION	_	81		HVDDOOSU			C ₂ H ₆		4.14
12	(This is Reference Temperature) † TEMPERATURE OF FUEL	F	3 5	44	HYDROGEN OXYGEN		56 57	C ₃ H ₈	·	0.15
13	GAS TEMP. LEAVING (Boiler) (狂欲放水水水水水水	F	5 1 7	46	NITROGEN		58	C ₂ H ₁ O)	0.02
14	GAS TEMP. ENTERING AH (If conditions to be	F							trogen.	
I	corrected to guarantee) UNIT QUANTITIES	<u> </u>	L	47 40	SULPHUR ASH		59 60	CO ₂		2.21
1,6		D. (II		37	<u> </u>	· · · · · · · · · · · · · · · · · · ·	 	 	HYDROGEN	0.36
15 16	ENTHALPY OF SAT. LIQUID (TOTAL HEAT) ENTHALPY OF (SATURATED) (SOFE SATURATED)	Btu/Ib	1100 5		MOISTURE		61	1112	TITOROGEN	
	STM.	Btu/Ib	1193.5		TOTAL				TOTAL	100.0
	ENTHALPY OF SAT. FEED TO (BOILER)	Btu/lb			COAL PULVERIZATIO) N			HYDROGEN	
17	(5x50kk)	010/10	184.1	48	GRINDABILITY		62	% wt	V 68 E	23.65 .588
18	ENTHALPY OF REHEATED STEAM R.H. INLET	Btu/Ib			INDEX*		02 	DENSIT	ATM. PRES	Ss. • 5,50
19	ÉNTHALPY OF REHEATED STEAM R. H. OUTLET	Btu/lb		49	FINENESS % THRU 50 M*		63	B P.E.	R CU FT	1006
20		Bru/Ib	1009.4	50	FINENESS % THRU	· · · · · · · · · · · · · · · · · · ·	41	Btu PE		22438
			2007		200 M*		L.,	ļ		130
21	HEAT ABS/LB R.H. STEAM (ITEM 19-ITEM 18)	Btu/1b		64	INPUT-OUTPUT EFFICIENCY OF UNI	Т %	į	TEM 31 >		
22	DRY REFUSE (ASH PIT + FLY ASH) PER LB								Btu/lb	% of A. F.
23	AS FIRED FUEL Biu PER LB IN REFUSE (WEIGHTED AVERAGE)	16/16 Bu/16		65	HEAT LOSS EFFIC				1790.39	7.98
24	CARBON BURNED PER LB AS FIRED FUEL	16/16	.7203	66	HEAT LOSS DUE TO		EINI	FUEL	1790.39	7.30
25	DRY GAS PER LB AS FIRED FUEL BURNED	16/16	17.11	67	HEAT LOSS DUE TO				2654.96	11.83
	HOURLY QUANTITIES			68	HEAT LOSS DUE TO				21.05	0.09
26	ACTUAL WATER EVAPORATED	lb/hr	20700	69	HEAT LOSS DUE TO		DN			1.30
27	REHEAT STEAM FLOW	lb/hr	<u> </u>	70	UNMEASURED LOSSE	5				0.50
28	RATE OF FUEL FIRING (AS FIRED wt) TOTAL HEAT INPUT (Item 28 × Item 41)	lb/hr	_	71	TOTAL					21.70
29	TOTAL HEAT INPUT (Item 28 × Item 41) 1000	kB/hr		72	EFFICIENCY = (100 -	- Item 71)				78.30
30	HEAT OUTPUT IN BLOW-DOWN WATER	k B/hr								
31	TOTAL (Item 26×Item 20)+(Item 27×Item 21)+Item 30	k8/hr								
	00TPUT 1000	<u> </u>	20890							
	FLUE GAS ANAL. (BOILER) (ECON) (AIR HTR)									
32	CO ₂	•	10.4		•					
33	0, C0	% VOL	1.93		*					
35	N ₂ (BY DIFFERENCE)	% VOL	.03 87.64		*Not Required for Effic	iency Test	ling			
36	EXCESS AIR	0′0	8.87		† For Point of Measuren	nent See P	ar. 7.	2.8.1-PT	C 4.1-1964	•
					† For Point of Measuren	nent See P	ar. 7.	2.8.1-PT	C 4.1-1964	•

The state of the s

ASME TEST FORM FOR ABBREVIATED EFFICIENCY TEST

					TEST NO. 3		OU 5	D.NO.	DATE	4/1/75
OWA	HER OF PLANT DND				TLATINO.				- DATE -	
	1 6 6 7 7	G Fo	uhee			Ottawa Accep				1 br
1	77	0. 10	unsc		BJECTIVE OF TEST	·			21 007	o _N 1 hr 1b/hr
	actly marke of the					R.A	TED	CAPACI	TY 31,000	10/111
	KER, TYPE & SIZE									
	VERIZER, TYPE & SIZE	· · · · · · · · · · · · · · · · · · ·				в	JRNE	R, TYPE	& SIZE 'I	odd
FUE	LUSED Natural Gas MINE		· · · · · · · · · · · · · · · · · · ·	cou	NTY	STATE			SIZE AS FI	RED
·	PRESSURES & TEMPERATURES	,		1		FUEL	DAT	ГА		
1	STEAM PRESSURE IN BOILER DRUM	psia	139.7		COAL AS FIRED PROX. ANALYSIS	% wt		1	OIL	
2	STEAM PRESSURE AT SX HX NX HXXXX HDR	psia	134.7	37	MOISTURE		51	FLASH	POINT F*	
3	STEAM PRESSURE AT R. H. INLET	psia		38	VOL MATTER		52	Sp. Grav	rity	
Ī .		<u> </u>	_		CIVED CLEROU				ITY AT SSU*	·
4	STEAM PRESSURE AT R. H. OUTLET	psia	<u> </u>	39	FIXED CARBON		53	BURNE	R SSF HYDR O GEN	
5	STEAM TEMPERATURE AT S. H. OUTLET	F	•	40	ASH		44	% wt	HIDROGEN	
6	STEAM TEMPERATURE AT R.H. INLET	F			TOTAL		41	Btu per	16	
7	STEAM TEMPERATURE AT R.H. OUTLET	F	ļ	41	Btu per Ib AS FIRED		ļ			ļ
8	WATER TEMP. ENTERING (EXON.) (BOILER)	F	217	42	ASH SOFT TEMP.* ASTM METHOD				GAS	% VOL
9	CTCANOUALITY & NOVETURE OF P. P.			t .	OAL OR OIL AS FIRED)				
10	STEAM QUALITY & MOISTURE OR P. P. M. AIR TEMP. AROUND BOILER (AMBIENT)	F	75	43	ULTIMATE ANALYSIS CARBON		54	CH ₄ N	METHANE	93.17
l	TEMP, AIR FOR COMBUSTION .	 		43	CARBON		55	· · · · · ·	MEINANE	
11	(This is Reference Temperature) †	F	81	44	HYDROGEN		56	C ₂ H ₆	······································	4.14
12	TEMPERATURE OF FUEL	F	35	45	OXYGEN		57	C ₃ H ₈		0.15
13	GAS TEMP, LEAVING (Boiler) (医器数类类数数类类	F	353	46	NITROGEN		58	C_4H_1		0.02
14	GAS TEMP, ENTERING AH (If conditions to be corrected to guarantee)	F]	47	SULPHUR		59	N2 N:	itrogen	2.21
	UNIT QUANTITIES			40	ASH		60	CO ₂		0.36
15	ENTHALPY OF SAT. LIQUID (TOTAL HEAT)	Btu/lb		37	MOISTURE		61	H ₂	HYDROGEN	
16	ENTHALPY OF (SATURATED) (SUKERNIH SWIXED)	Btu/lb	1193.0		TOTAL					100 00
-	STM. ENTHALPY OF SAT. FEED TO (BOILER)	DIU/IB		<u> </u>	TOTAL		<u> </u>	I TOTAL		100.00
17	(ACCON.)	Btu/lb	185.1		COAL PULVERIZATION	N		% wt	HYDROGEN	23.65
,,	ENTINAL DV OF DEHICATED SECAND II IN ET	D. 41		48	GRINDABILITY		62	DENSIT	Y 68 F	588
18	ENTHALPY OF REHEATED STEAM R.H. INLET	Btu/1b		49	INDEX* FINENESS % THRU				ATM. PRE	
19	OUTLET	Btu/lb			50 M*		63	Bto PE	R CU FT	1006
20	HEAT ABS/LB OF STEAM (ITEM 16 - ITEM 17)	Btu/Ib	1007.9	50	FINENESS % THRU 200 M*		41	Bto PE	R LB	
21	UCATADO/IDD II CTEAN/ITEN 10 ITEN 10)	D. (1)	<u> </u>		INPUT-OUTPUT		l	TEM 31 :	< 100	l
<u> </u>	HEAT ABS/LB R.H. STEAM(ITEM 19-ITEM 18)	/Ib		64	EFFICIENCY OF UNI	Т %		ITEM 2	9	
2 2	DRY REFÜSE (ASH PIT + FLY ASH) PER LB AS FIRED FUEL	1b/1b			HEAT LOSS EFFIC	IENCY			Btu/lb A.F. FUEL	% of A. F. FUEL
23	Btu PER LB IN REFUSE (WEIGHTED AVERAGE)			65	HEAT LOSS DUE TO				1197.24	5.35
24	CARBON BURNED PER LB AS FIRED FUEL	lb/lb	.7203	66	HEAT LOSS DUE TO	MOISTURE	IN F	UEL		
25	DRY GAS PER LB AS FIRED FUEL BURNED	lb/lb	18.34	67	HEAT LOSS DUE TO		COM	B. O F H ₂	2492.60	
1 2/	HOURLY QUANTITIES	11. /	5000	68	HEAT LOSS DUE TO			·	15.06	0.07
26 27	ACTUAL WATER EVAPORATED	lb/hr lb/hr	5000	69 70	HEAT LOSS DUE TO		אי			5.00
28	REHEAT STEAM FLOW RATE OF FUEL FIRING (AS FIRED wt)	lb/hr	 	70	TOTAL	. 3				0.50
29	TOTAL HEAT INPUT (!tem 28 x Item 41)	 		72	EFFICIENCY = (100 -	lan 711		· · · · · · · · · · · · · · · · · · ·		
	1000	kB/hr		12	ETTICIENCE = (100 -	- iiem /()		·····		77.97
30	HEAT OUTPUT IN BLOW-DOWN WATER	kB/hr			•					
31	TOTAL HEAT (Item 26×Item 20)+(Item 27×Item 21)+ Item 30	kB/hr	5040							
L	OUTPUT 1000	<u> </u>								
	FLUE GAS ANAL. (BOILER) (ECON) (AIR HTR)		,							
32	CO ₂	% VOL	9.7		•					
33	0 ₁	% VOL	3.6	,	talon i ir men					
35	N ₂ (BY DIFFERENCE)	% VOL			Not Required for Effici	ency lest	ıng			
36	EXCESS AIR	%	86.68 18.26		t For Point of Measurem	ient See Po	ar. 7.2	2.8.1-PT	C 4.1-1964 .	

PTC 4.1-a (1964)

TABLE 8

SUMMARY SHEET

ASME TEST FORM
FOR ABBREVIATED EFFICIENCY TEST

					TEST NO. 4	В.	OILE	R NO.	2 DATE I	5/1/75
OWN	ER OF PLANT DND					B Ottav				
TES	T CONDUCTED BY A.C.S. Hayden, R.G	. Fou	hse	C	BJECTIVE OF TEST				DURATIO	N 1 hr
BOIL	ER, MAKE & TYPE Foster Wheeler	···	· · · · · · · · · · · · · · · · · · ·						TY 31,000) 1b/hr
STO	KER, TYPE & SIZE								······································	
PUL	VERIZER, TYPE & SIZE	···············				BU	RNE	R, TYPE	& SIZE To	odd
	LUSED No. 4 fuel oil MINE			COU	NTY	STATE			SIZE AS FIF	RED -
	PRESSURES & TEMPERATURES					FUEL	DA	ΓA		
1	STEAM PRESSURE IN BOILER DRUM	psia	140.7		COAL AS FIRED PROX. ANALYSIS	% wt			oiL	
2	STEAM PRESSURE AT XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	psio	134.7	37	MOISTURE		51	FLASH	POINT F*	
3	STEAM PRESSURE AT R. H. INLET	psia		38	VOL MATTER		52	Sp. Grav	ity	0.898
4	STEAM PRESSURE AT R. H. OUTLET	psia		39	FIXED CARBON .		53	VISCOS BURNE	ITY AT SSU*	
								TOTAL	HYDROGEN	12.32
5	STEAM TEMPERATURE AT S. H. OUTLET	<u> </u>		40	ASH TOTAL		41	% wt		20432
6	STEAM TEMPERATURE AT R.H. INLET STEAM TEMPERATURE AT R.H. OUTLET	F		41	Btu per Ib AS FIRED		41	Btu per	10	10.32
	STEAM TEMPERATURE AT R.H. OUTLET		017	7:	ASH SOFT TEMP,*					
8	WATER TEMP. ENTERING (KKXXX) (BOILER)	F	217	42	ASTM METHOD OAL OR OIL AS FIRED	L		Т	GAS	% VOL
9	STEAM QUALITY % MOISTURE OR P.P.M.				ULTIMATE ANALYSIS		54	co		
10	AIR TEMP. AROUND BOILER (AMBIENT)	F	72	43	CARBON	86.37	55	CH ₄ A	METHANE	
11	TEMP. AIR FOR COMBUSTION	_	82		11115500511	12.36	F./			
12	(This is Reference Temperature) † TEMPERATURE OF FUEL	F	106	44	HYDROGEN OXYGEN	_	56 57	}		
13	GAS TEMP. LEAVING (Boiler) (E&K.) XXXXXXXXX	F	633	46	NITROGEN	0.11	58	1		
14	GAS TEMP. ENTERING AH (If conditions to be		000			1.14				
	corrected to guarantee) UNIT QUANTITIES	<u> </u>	L	47	SUL PHUR A SH		59 60	CO,		
		lp. (1)	T .	⊢∸		0.02	61	H ₂	HYDROGEN	
15 16	ENTHALPY OF SAT. LIQUID (TOTAL HEAT) ENTHALPY OF (SATURATED) (多数學學學科學文學學科學文學學科	Btu/1b	7700 7	3/	MOISTURE		01	1''2	THE OFFICE OF THE OFFI	
	STM.	Btu/Ib	1193.1	<u> </u>	TOTAL	100.0	ļ	1	TOTAL	
17	ENTHALPY OF SAT, FEED TO (BOILER) (養養養養)	Btu/lb	185.1		COAL PULVERIZATIO	иĊ		TOTAL % wt	HYDROGEN	,
		D (11		48	GRINDABILITY		62	DENSIT	Y 68 F ATM. PRE	
18	ENTHALPY OF REHEATED STEAM R. H. INLET ENTHALPY OF REHEATED STEAM R. H.	Btu/Ib		49	INDEX* FINENESS % THRU		-	 	AIM. FKC]
19	OUTLET	Btu/lb			50 M*		63	Btu PE	R CU FT	
20	HEAT ABS/LB OF STEAM (ITEM 16 - ITEM 17)	Btu/Ib	1008.0	50	FINENESS % THRU 200 M*		41	Btu PE	R LB	
21	HEAT ABS/LB R.H. STEAM (ITEM 19-ITEM 18)	Btu/Ib		64	INPUT-OUTPUT	LT nr		ITEM 31	h/	.86
22	DRY REFUSE (ASH PIT + FLY ASH) PER LB	-			EFFICIENCY OF UNI	11 76		ITEM 2	Btu/lb	% of A. F
	AS FIRED FUEL	1b/1b		- <u>-</u> -	HEAT LOSS EFFIC				A. F. FUEL	FUEL
23	Btu PER LB IN REFUSE (WEIGHTED AVERAGE) CARBON BURNED PER LB AS FIRED FUEL	IP/IP	0627	65 66	HEAT LOSS DUE TO		= IN	FIIFI	2086.75	10.21
25	DRY GAS PER LB AS FIRED FUEL BURNED	1b/1b	.8637 15.78	67	HEAT LOSS DUE TO				1447.86	7.09
	HOURLY QUANTITIES	1 .2, 12		68	HEAT LOSS DUE TO					
26	ACTUAL WATER EVAPORATED	lb/hr	296 0 0	69	HEAT LOSS DUE TO		N			0.90
27	REHEAT STEAM FLOW	lb/hr		70	UNMEASURED LOSSE	ES				0.50
28	RATE OF FUEL FIRING (AS FIRED wt)	lb/hr	2152	71	TOTAL					18.70
2 9	TOTAL HEAT INPUT (Item 28 × Item 41)	kB/hr	43970	72	EFFICIENCY = (100	- Item 71)			· · · · · · · · · · · · · · · · · · ·	81.30
30	HEAT OUTPUT IN BLOW-DOWN WATER	kB/hr								
31	TOTAL (Item 26×Item 20) (Item 27×Item 21) + Item 30 OUTPUT 1000	kB/hr	29837			•		*		
	FLUE GAS ANAL. (BOILER) (ECON) (AIR HTR)	OUTLE	T -						•	
32	CO,	% VOL	13.9	1				-	•	
33	0,	% VOL	2.51				٠.			
34	CO	% VOL			* Not Required for Effic	ioncy Tes	ting			
35 36	N, (BY DIFFERENCE) . EXCESS AIR	% VOL	83.59		t For Point of Measurer	mant er = D	a. 7	281.07	C A 1 1044	•
, JU	L LACESS MIK	1 70	12.61	ı	.t i or i omi or measurer	went Jee L	wı. /.	T. 10. 1 . L. 1	C 411-1704	

ASME TEST FORM FOR ABBREVIATED EFFICIENCY TEST

_			····		TEST NO. 5	D.	OII EI	R NO.2	DATE 1	5/1/75
0.925	ER OF PLANT DND.					Ottawa			DATE	7/1/13
	A C C Maridan D	G. Fo	uhse		LOCATION				SUD LTI	
1					BJECTIVE OF TEST	Acce			· · · · · · · · · · · · · · · · · · ·	N1 hr
·	ER, MAKE & TYPE Foster Wheeler					RA	TED	CAPACI	TY 31,000) 1b/hr
!	KER, TYPE & SIZE									
PUL	VERIZER, TYPE & SIZE		·····			BL	RNE	R, TYPÉ	& SIZE	lodd
⊮FUE	LUSED No. 4 fuel oil MINE			COU	NTY .	STATE			SIZE AS FI	RED
	PRESSURES & TEMPERATURES	,	 	<u> </u>		FUEL	DAT	ГА <u>.</u>		
1	STEAM PRESSURE IN BOILER DRUM	psia	138.7		COAL AS FIRED PROX. ANALYSIS	% wt			OIL	
2	STEAM PRESSURE AT KNEW CHEEK HDR	psia -	132.7	37	MOISTURE		51	FLÀSH	POINT F*	
3	STEAM PRESSURE AT R. H. INLET	psia		38	VOL MATTER		52	Sp. Grav	ity	0.898
		,,,,,,							ITY AT SSU*	,
4	STEAM PRESSURE AT R. H. OUTLET	psia		39	FIXED CARBON		53	BURNE	R SSF HYDROGEN	
5	STEAM TEMPERATURE AT S. H. OUTLET	F		40	ASH	`	44	% wt	n i DRUGEN	12.32
6	STEAM TEMPERATURE AT R.H. INLET	F			TOTAL		41	Btu per	lb .	20432
. 7	STEAM TEMPERATURE AT R.H. OUTLET	F		41	Btu per 1b AS FIRED					
8	WATER TEMP, ENTERING (崔哲敬敬)(BOILER)	F.	202	42	ASH SOFT TEMP.* ASTM METHOD				GAS	% YOL
ů	WATER TEMP. ENTERING (ECON) (BOILER)	- '			OAL OR OIL AS FIRED)				
9	STEAM QUALITY% MOISTURE OR P. P. M.	<u> </u>			ULTIMATE ANALYSIS	106.07	54	C0		
10	AIR TEMP. AROUND BOILER (AMBIENT)	F	74	43	CARBON	86.37	55	CH₄ M	METHANE	
11	TEMP. AIR FOR COMBUSTION (This is Reference Temperature) †	F	81	44	HYDROGEN	12.36	56			
12	TEMPERATURE OF FUEL	F	106	45	OXYGEN	_	57			
13	GAS TEMP. LEAVING (Boiler)法既認此來依然以外以	F	535	46	NITROGEN	0.11	58		·····	
14	GAS TEMP. ENTERING AH (If conditions to be	F		47		1.14	59	1		
L	corrected to guarantee) UNIT QUANTITIES	<u> </u>	L.,	47 40	SULPHUR ASH	0.02	60	CO ₂		
,,,) ₂ (1)	 	37		0.02	61		HYDROGEN	
15 16	ENTHALPY OF SAT. LIQUID (TOTAL HEAT) ENTHALPY OF (SATURATED) (XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	Btu/Ib	1192.9	_3/	MOISTURE		01	1 1 12	TITOROGER	
10	STM.	Btu/Ib	1172.9		TOTAL	100.0			TOTAL	
	ENTHALPY OF SAT. FEED TO (BOILER)	Btu/lb	170 0		COAL PULVERIZATION	אר			HYDROGEN	
_17	(R&CVX)	Bru/ IB	170.0		GRINDABILITY	,	62	% wt DENSIT	V 40 E	L
18	ENTHALPY OF REHEATED STEAM R.H. INLET	Btu/lb		48	INDEX*		02	DENSIT	ATM. PRES	s.
19	ENTHALPY OF REHEATED STEAM R. H.			49	FINENESS % THRU 50 M*	157,2				
20	OUTLET HEAT ABS/LB OF STEAM (ITEM 16 – ITEM 17)	Btu/Ib	1022 0	50	FINENESS % THRU		63 41		R CU FT	
20	TIEAT ABS/LB OF STEAM (TIEM TO = TIEM T/)	510/16	1022.9		200 M*	<u> </u>		Btu PE		
21	HEAT ABS/LB R. H. STEAM (ITEM 19-ITEM 18)	Btu/lb		64	INPUT-OUTPUT	. 	Ī	TEM 31 >	(100 66.39	9
22	DRY REFUSE (ASH PIT + FLY ASH) PER LB				EFFICIENCY OF UNI	11 %		ITEM 2	Btu/lb	% of A. F.
	AS FIRED FUEL	1Ь/1Ь	L		HEAT LOSS EFFIC				A. F. FUEL	FUEL
23	BIU PER LB IN REFUSE (WEIGHTED AVERAGE)	 		65	HEAT LOSS DUE TO				1789.12	8.76
24	CARBON BURNED PER LB AS FIRED FUEL	1b/1b	.8637	66	HEAT LOSS DUE TO				1307 03	6.84
25	DRY GAS PER LB AS FIRED FUEL BURNED	16/16	16.42	67	HEAT LOSS DUE TO		COM	D. UF H ₂	19.75	$\frac{0.34}{0.10}$
26	HOURLY QUANTITIES ACTUAL WATER EVAPORATED	lb/hr	19010	68 69	HEAT LOSS DUE TO		N		-20075	$\frac{0.10}{1.40}$
27	REHEAT STEAM FLOW	lb/hr		70	UNMEASURED LOSSE					0.50
28	RATE OF FUEL FIRING (AS FIRED wt)	lb/hr	1434	71	TOTAL					17.60
29	TOTAL HEAT INPUT (Item 28 × Item 41)	i .	29290	72	EFFICIENCY = (100 -	- Item 71)		· · · · · · · · · · · · · · · · · · ·		82,40
	1000	ļ	27270						· ·	
30	HEAT OUTPUT IN BLOW-DOWN WATER	kB/hr	 							
31	TOTAL HEAT (Item 26×Item 20)+(Item 27×Item 21)+Item 30	kB/hr	10665							
<u> </u>	OUTPUT 1000	L E	19445		•				•	
22	FLUE GAS ANAL. (BOILER) (ECON) (AIR HTR)	WILE	13.3		•				•	
32	CO ₂	% VOL	3.50		•					
34	C0	% VOL	.03		* Not Required for Effic	ioneu Test	in-			
35	N ₂ (BY DIFFERENCE)	% VOL	83.17		wor wednised for Eithe	rency lest	g			
36	EXCESS AIR	°;	18.52		t For Point of Measuren	nent See P	ar. 7.2	2.8. 1- PT0	C 4.1-1964	
					•					,

ASME TEST FORM FOR ABBREVIATED EFFICIENCY TEST

	Control of the Contro				TEST NO. 6	В	OILE	RNO. 2	DATE]	5/1/75
OWNE	ROFPLANT DND				LOCATION CI	FB Otta	wa	North		
TEST	CONDUCTED BY A.C.S. Hayden, R.	G. Fo	uhse	0	BJECTIVE OF TEST	Ассер	tar	ice ·	DURATIO	N.5 hr
BOILE	R. MAKE & TYPE Foster Wheeler					RA	TED	CAPACI	TY 31,000	1b/hr
STOK	ER, TYPE & SIZE				,			,		
	ERIZER, TYPE & SIZE	·	**			BU	RNE	R, TYPE	& SIZE	odd.
	USED No. 4 fuel oil MINE			COU	UTV	STATE		,	SIZE'AS FIF	FD.
FUEL	PRESSURES & TEMPERATURES			COU	111	FUEL		TA	312.L A3 1 11	
, [· .			COAL AS FIRED	٠.		Ī		
	STEAM PRESSURE IN BOILER DRUM	psia	135.7		PROX. ANALYSIS	% wt			OIL	· · ·
2	STEAM PRESSURE AT XXXXXXXXXXXXX	psia	129.7	37	MOISTURE		51	FLASH	POINT F*	
3	STEAM PRESSURE AT R. H. INLET	psia		38	VOL MATTER		52	Sp. Grav	ity ·	0.998
					EIVED CARRON				TY AT SSU*	
4	STEAM PRESSURE AT R. H. OUTLET	psia		39	FIXED CARBON		53	BURNE	R SSF HYDROGEN	l
5	STEAM TEMPERATURE AT S. H. OUTLET	·F		40	ASH		44	% wt		12.36
6	STEAM TEMPERATURE AT R.H. INLET	F			TOTAL		41	Btu per	lb	20432
7	STEAM TEMPERATURE AT R.H. OUTLET	F	·	41	Btu per 1b AS FIRED					
8	WATER TEMP. ENTERING (% 88%) (BOILER)	F	204	42	ASH SOFT TEMP.* ASTM METHOD				GAS	% YOL
	WATER TEMP. ENTERING (GOOK) (BOILER)				DAL OR OIL AS FIRED)		T		
9	STEAM QUALITY % MOISTURE OR P.P.M.	<u></u>			ULTIMATE ANALYSIS	· ·····	54	CO	·	<u> </u>
	AIR TEMP. AROUND BOILER (AMBIENT)	F	75	43	CARBON	86.37	55	CH₄ M	THANE	
	TEMP. AIR FOR COMBUSTION (This is Reference Temperature) †	F	80	44	HYDROGEN	12.36	56	C ₂ H ₂ A	CETYLENE	}
	TEMPERATURE OF FUEL	F	106	45	OXYGEN		57	C ₂ H ₄ E	THYLENE	
	GAS TEMP. LEAVING (Boiler) (EXXX (XXXXX)	F	435	46	NITROGEN	0.11	58	+	THANE	
	GAS TEMP. ENTERING AH (If conditions to be corrected to guarantee)	<u> </u>				1.14	59	H ₂ S		
		F	L	47	SULPHUR	 		 		
	UNIT QUANTITIES		r	40	ASH	0.02	60	CO ₂	UVDDOCEN	ļ
	ENTHALPY OF SAT. LIQUID (TOTAL HEAT)	Btu/1b	1100 5	37	MOISTURE		61	1 172	HYDROGEN	
16	ENTHALPY OF (SATURATED) (多数产量管理等基本差数) STM.	Btu/1b	1192.5	l	TOTAL	100.0			TOTAL	
	ENTHALPY OF SAT. FEED TO (BOILER)		172.0	·	CO.11 DIII VEDITATI	~		TOTAL	HYDROGEN	
17	(X & & & & &)	Btu/lb			COAL PULVERIZATION) N		% wt		<u> </u>
18	ENTHALPY OF REHEATED STEAM R.H. INLET	Btu/lb		48	GRINDABILITY INDEX*	ĺ	62	DENSIT	Y 68 F ATM. PRE	ss.
	ENTHALPY OF REHEATED STEAM R. H.	019710		49	FINENESS % THRU					
19	OUTLET	Btu/lb_		ļ	50 M*		63		RCUFT	
20	HEAT ABS/LB OF STEAM (ITEM 16 - ITEM 17)	Btu/lb	1020.5	50	FINENESS % THRU 200 M*	Į	41	Btu PE	R LB	
21	HEAT ABS/LB R.H. STEAM (ITEM 19-ITEM 18)	B 4 /1L	-	64	INPUT-OUTPUT	I	L	ITEM 31 >	< 100 66	.55
	HEAT ABS/LB R.H. STEAM(ITEM TY=ITEM TO)	D10/16		04	EFFICIENCY OF UN	IT %		ITEM 2	9	
22	DRY REFUSE (ASH PIT + FLY ASH) PER LB AS FIRED FUEL	 b/ b			HEAT LOSS EFFI	TIENCY			Btu/lb A. F. FUEL	% of A. FUEL
23	Btu PER LB IN REFUSE (WEIGHTED AVERAGE)			65	HEAT LOSS DUE TO			· · · · · · · · · · · · · · · · · · ·	1675.88	8.20
24	CARBON BURNED PER LB AS FIRED FUEL	lb/lb	.8637	66	HEAT LOSS DUE TO	MOISTURI	E IN	FUEL		
25	DRY GAS PER LB AS FIRED FUEL BURNED	1b/1b	19.67	67	HEAT LOSS DUE TO	H ₂ O FROM	CO	MB.OFH₂	1345.96	6.59
······	HOURLY QUANTITIES	· · · · · -		68	HEATLOSS DUE TO	CO			23.87	0.12
	ACTUAL WATER EVAPORATED	lb/hr	9700	69	HEAT LOSS DUE TO	RADIATIO	N			2.70
	REHEAT STEAM FLOW	lb/hr.	700	70	UNMEASURED LOSSI	ES _.				0.50
28	RATE OF FUEL FIRING (AS FIRED wi)	lb/hr	728	71	TOTAL					18.11
29	TOTAL HEAT INPUT (Item 28 × Item 41)	kB/hr	14874	72	EFFICIENCY = (100	- Item 71)	•			81.89
30	HEAT OUTPUT IN BLOW-DOWN WATER	kB/hr					•		·	
			<u> </u>	l						
	TOTAL HEAT (<u> 1 tem 26 × 1 tem 20) (1 tem 27 × 1 tem 21) + 1 tem 30 1 </u>	kB/hr	9899							
	FLUE GAS ANAL. (BOILER) (ECON) (AIR HTR)	OUTLE:	<u> </u>							
32	CO ₂	% VOL	11.0				•			
33	0,	% VOL	6.0		•		•			
34	co	% VOL	0.03		* Not Required for Effic	iency Test	ino			•
35	N ₁ (BY DIFFERENCE)	% VOL	82.97]	q=e iei Eiiie					
36	EXCESS AIR	0,0	36.79		† For Point of Measures	nent See P	ar. 7.	2.8.1-PT	C 4.1-1964	

TABLE 11

ASME TEST FORM FOR ABBREVIATED EFFICIENCY TEST

SUMMARY SHEET

					TEST NO. 7		011 5	R NO. 2	DATE 1	71/75
<u></u>	200				TEST NO.				DATE 1-	
OWN	ER OF PLANT DND				LOCATION CFB	Ot tawa	a No	rth		
TES	T CONDUCTED BY A.C.S. Hayden, R.G	. Fou	hse.	0	BJECTIVE OF TEST					οN .25Hr
BOIL	ER, MAKE & TYPE Foster Wheeler					R.A	TED	CAPACI	TY 31,000) 1b/hr
STO	KER, TYPE & SIZE									
PUL	VERIZER, TYPE & SIZE	····				BU	RNE	R, TYPE	& SIZE TO	odd
34-7-12-7	LUSED No. 4 fuel oilmine			COU	NTY	STATE			SIZE AS FIF	OFD.
1 100	PRESSURES & TEMPERATURES					FUEL		ΓΑ	JIZE AUTH	
<u> </u>	STEAM PRESSURE IN BOILER DRUM		135.7		COAL AS FIRED			T T		
	STEAM PRESSURE IN BOILER DROM	psia			PROX. ANALYSIS	% wt	 	ļ	OIL	
2	STEAM PRESSURE AT XXXXXXXXXX HDR	psia	129.7	37	MOISTURE		51	FLASH	POINT F*	<u> </u>
3	STEAM PRESSURE AT R. H. INLET	psia		38	VOL MATTER		52	Sp. Grav	ity	0.898
	ATEAN PRESSURE AT D. H. OUTLET			20	FIXED CARBON				TY AT SSU*	1
4	STEAM PRESSURE AT R. H. OUTLET	psia		39	PIXED CARBON		53	TOTAL	<u>R SSF</u> HYDROGEN	12.32
5	STEAM TEMPERATURE AT S. H. OUTLET	F		40	ASH		44	% wt		! 5
6	STEAM TEMPERATURE AT R.H. INLET	F			TOTAL		41	Btu per	lb	20432
7	STEAM TEMPERATURE AT R.H. OUTLET	F		41	Btu per Ib AS FIRED		ļ			ļļ
8	WATER TEMP. ENTERING (苍苍弥天) (BOILER)	F	212	42	ASH SOFT TEMP.* ASTM METHOD		1		GAS	% VOL
	THATER TEMP. ENTERING (EEGIN, (BOTELK)	\			OAL OR OIL AS FIRED)				
9	STEAM QUALITY % MOISTURE OR P. P. M.				ULTIMATE ANALYSIS		54	co		
10	AIR TEMP. AROUND BOILER (AMBIENT)	F	75	43	CARBON	86.37	55	CH₄ M	IETHANE	
11	TEMP. AIR FOR COMBUSTION	F	80		HYDROGEN	12.36	56	C ₂ H ₂ A	CETYLENE	
12	(This is Reference Temperature) † TEMPERATURE OF FUEL	F	106	44	OXYGEN		57	J	THY LENE	
		F				0.11	58	+	THANE	
13	GAS TEMP. LEAVING (Boiler) 長安安太 (Air 共成) GAS TEMP. ENTERING AH (If conditions to be	<u> </u>	370	46	NITROGEN			 	- 1117116	
·	corrected to guarantee)	F	l	47	SULPHUR.	1.14	59	H ₂ S	·····	
.	UNIT QUANTITIES			40	ASH	0.02	60	CO ₂		<u> </u>
15	ENTHALPY OF SAT. LIQUID (TOTAL HEAT)	Btu/Ib		37	MOISTURE		61	H ₂	HYDROGEN	
16	ENTHALPY OF (SATURATED) (SUMPERMENTED)	D . (1)	1 1925			100.0	Į		=	
-	STM.	Btu/Ib	100 1	<u> </u>	TOTAL	100.0		T	TOTAL.	
17	ENTHALPY OF SAT. FEED TO (BOILER)	Btu/Ib	180.1	ĺ	COAL PULVERIZATION	N		TOTAL	HYDROGEN	!
-'-	(安安)(次)			48	GRINDABILITY		62	DENSIT	Y 68 F	
18	ENTHALPY OF REHEATED STEAM R. H. INLET	Btu/lb			INDEX*		L	ļ	ATM. PRES	SS.
19	ENTHALPY OF REHEATED STEAM R. H.	D. 71	·	49	FINENESS % THRU 50 M*		63	B. DE	R CU FT	
20	OUTLET HEAT ABS/LB OF STEAM (ITEM 16 - ITEM 17)	Btu/lb	1012.4	50	FINENESS % THRU		41	Btu PE		
	TIEM ADDIES OF STEAM (TEM TO THEM 17)	10,15	1012.4		200 M*		<u> </u>	Diu FC		L
21	HEAT ABS/LB R.H. STEAM (ITEM 19-ITEM 18)	Btu/lb	1	64	INPUT-OUTPUT	T 07	!	TEM 31 >		97
22	DRY REFUSE (ASH PIT + FLY ASH) PER LB	 	<u> </u>	 	EFFICIENCY OF UN	76		ITEM 2	Btu/lb	% of A. F.
	AS FIRED FUEL	16/16	<u> </u>	<u> </u>	HEAT LOSS EFFIC	CIENCY			A.F. FUEL	FUEL
23	Biu PER LB IN REFUSE (WEIGHTED AVERAGE)	Btu/lb		65	HEAT LOSS DUE TO	DRY GAS			1357.20	6.64
24	CARBON BURNED PER LB AS FIRED FUEL	16/16	.8637	66	HEAT LOSS DUE TO					
25	DRY GAS PER LB AS FIRED FUEL BURNED	16/16	19.50		HEAT LOSS DUE TO		COY	AB.OFH₂	1312.50	6.42
1	HOURLY QUANTITIES	111.7	F 600	68	HEAT LOSS DUE TO				23.65	0.12 4.50
26	ACTUAL WATER EVAPORATED	lb/hr	5680	69	HEAT LOSS DUE TO		אנ			0.50
27	REHEAT STEAM FLOW	lb/hr	207	70	UNMEASURED LOSSI	= 5				18.18
28	RATE OF FUEL FIRING (AS FIRED wt)	lb/hr	391	71	TOTAL					10.10
29	TOTAL HEAT INPUT (Item 28 × Item 41)	kB/hr	7989	72	EFFICIENCY = (100	- Item 71)				81.82
30	HEAT OUTPUT IN BLOW-DOWN WATER	kB/hr		1			***************************************	<u> </u>		
		 								
31	TOTAL (tem 26x tem 20) + (tem 27x tem 21) + tem 30 OUTPUT 1000	kB/hr	5750	Ì						
Ĭ	FLUE GAS ANAL. (BOILER) (ECON) (AIR HTR)	OUTLE	ι Γ				•			
32	Co,	% VOL	11.1	l						
33	0,	% VOL	5.8	[•			
34	co	% VOL	.03	•	* Not Required for Effic	lency Tes	ting			
35	N ₂ (BY DIFFERENCE)	% VOL	83.07	3	Not redouted for File		9			
36	EXCESS AIR		35.07	1	t For Point of Measurer	nent See P	ar. 7.	2.8.1.PT	C 4.1-1964	
•				-						

APPENDIX A.

BOILER AND BURNER SPECIFICATIONS

1. Boilers:

No. 1: Inglis, Type VL, 400 HP

No. 2: Foster Wheeler, 31,000 lb/hr

No. 3 & No. 4: Waterous, 31,000 lb/hr

2. Burners:

No. 1: 2 parallel Compower oil/gas burners

No. 2: Todd D18, Number 197354

Input Btu: min 5.5 MM, max 31 MM

Natural gas and No. 4 oil

Inlet gas: 10 psig Steam atomized oil burner

Manifold gas: 3 psig Oil pressure: 100 psig

Max gas I/P: 8750 CFM Max oil I/P: 2100 lb/hr

No. 3 & No. 4: Single Compower oil/gas burner