VERSION: 2.4 4/15/2010

lanufacturer: Arada
Model: Farringdon 16
Date: 2/21/2017
Run: 3
Control #: 035-S-075-1
est Duration: 250
urn Category 2

Appliance Type: Cat (Cat, Non-Cat, Pe
Temp. Units F (F or C)
Weight Units lb (kg or lb)

Wood Moisture (% DRY):	19.3
Wood Moisture (% wet):	16.18
Load Weight (lb wet):	10.70
Burn Rate (dry kg/h):	0.98
Total Particulate Emissions:	8.31 g

Fuel Data	D. Fir	
HHV	19,810	kJ/kg
%C	48.73	
%H	6.87	
%O	43.90	
%Ash	0.50	

Averages		241.4	69.9	9.63	11.23	0.38
		Temp. (F)				
Elapsed Time (min)	Fuel Weight Remaining (lb)	Flue Gas	Room Temp	Flue Gas Composition (%) O2	CO2	CO
0	10.7	229.0	72.0	14.52	5.80	0.02
10	10.1	245.0	70.0	14.35	6.40	0.02
20	9.4	239.0	70.0	12.87	8.27	0.03
30	9.0	246.0	69.0	12.01	9.26	0.05
40	8.5	253.0	69.0	10.71	10.78	0.06
50	7.9	290.0	69.0	6.34	15.11	0.12
60	6.8	330.0	69.0	5.32	14.99	2.62
70	5.7	320.0	69.0	5.13	15.65	1.51
80	4.6	320.0	70.0	4.92	15.03	3.90
90	3.7	304.0	70.0	5.07	15.60	1.19
100	3.2	268.0	70.0	9.65	11.19	0.03
110	2.9	255.0	70.0	10.64	10.13	0.03
120	2.6	247.0	70.0	10.64	10.21	0.03
130	2.3	240.0	70.0	10.58	10.39	0.03
140	1.9	245.0	70.0	9.15	12.06	0.06
150	1.6	241.0	70.0	9.51	11.40	0.03
160	1.4	229.0	70.0	9.42	11.43	0.04
170	1.2	220.0	70.0	9.69	11.09	0.02
180	1.0	208.0	70.0	10.04	10.75	0.02
190	0.9	201.0	70.0	9.50	11.27	0.02
200	0.7	198.0	70.0	9.60	11.21	0.02
210	0.6	195.0	70.0	10.32	10.60	0.02
220	0.5	191.0	70.0	10.27	10.57	0.03
230	0.3	189.0	70.0	9.79	11.23	0.02
240	0.2	187.0	70.0	10.07	10.90	0.02
250	0.0	186.0	70.0	10.38	10.57	0.02

Manufacturer:	Arada
Model:	Farringdon 16
Date:	2/21/2017
Run:	3
Control #:	035-S-075-1
Test Duration:	250 min

	HHV	LHV
Eff	79.5%	85.9%
Comb Eff	96.0%	96.0%
HT Eff	82.8%	89.5%
Output	15,379	kJ/h
Burn Rate	0.98	kg/h
Grams CO	231	g
Input	19,348	kJ/h
MC wet	16.18	

Ultimate CO2

CO2-ult 19.64

F0 1.063

Averages	0.38	11.23	81.6%	20.17	8.76	116.3

INPUT DATA				**Oxygen Calculation**			**Input**
Elapsed Time	**Weight Remaining (kg)**	**% CO [e]**	**% CO2 [d]**	**Excess Air EA**	**Total O2**	**Calc. % O2 [g]**	**Flue Gas (ºC)**
0	4.85	0.02	5.80	237.5%	20.56	14.75	109.4
10	4.58	0.02	6.40	206.0%	20.52	14.11	118.3
20	4.26	0.03	8.27	136.7%	20.39	12.11	115.0
30	4.08	0.05	9.26	111.0%	20.33	11.04	118.9
40	3.86	0.06	10.78	81.2%	20.22	9.41	122.8
50	3.58	0.12	15.11	29.0%	19.93	4.76	143.3
60	3.09	2.62	14.99	11.5%	19.78	3.48	165.6
70	2.59	1.51	15.65	14.5%	19.81	3.40	160.0
80	2.09	3.90	15.03	3.8%	19.69	2.71	160.0
90	1.68	1.19	15.60	17.0%	19.83	3.64	151.1
100	1.45	0.03	11.19	75.1%	20.20	8.99	131.1
110	1.32	0.03	10.13	93.3%	20.27	10.12	123.9
120	1.18	0.03	10.21	91.8%	20.26	10.04	119.4
130	1.04	0.03	10.39	88.5%	20.25	9.85	115.6
140	0.86	0.06	12.06	62.1%	20.14	8.05	118.3
150	0.73	0.03	11.40	71.9%	20.19	8.77	116.1
160	0.64	0.04	11.43	71.3%	20.18	8.73	109.4
170	0.54	0.02	11.09	76.8%	20.21	9.11	104.4
180	0.45	0.02	10.75	82.4%	20.23	9.47	97.8
190	0.41	0.02	11.27	74.0%	20.19	8.91	93.9
200	0.32	0.02	11.21	74.9%	20.20	8.98	92.2
210	0.27	0.02	10.60	85.0%	20.24	9.63	90.6
220	0.23	0.03	10.57	85.3%	20.24	9.66	88.3
230	0.14	0.02	11.23	74.6%	20.20	8.96	87.2
240	0.09	0.02	10.90	79.9%	20.22	9.31	86.1
250	0.00	0.02	10.57	85.5%	20.24	9.66	85.6

			Air Fuel Ratio (A/F)			
Overall Heating Efficiency:	79.5%		Dry Molecular Weight (Md)		30.15	
Combustion Efficiency:	96.0%		Dry Moles Exhaust Gas (Nr):		340.28	%HC
Heat Transfer Efficiency:	82.8%		Air Fuel Ratio (A/F)		9.75	0.88

Heat Output:	14,589	Btu/h	15,379	kJ/h
Heat Input:	18,353	Btu/h	19,348	kJ/h

2

Burn Duration:	4.166666667	h		
Burn Rate:	2.2	lb/h	1.0	kg/h
Stack Temp:	241.9	Deg. F	116.6	Deg. C

21.0	98.4%	83.7%	82.4%	11.0	1.70	64.88	0.04	64.88
Data	**Combust**	**Heat**	**Net**	**Air**	**Wet Wt**	**% Wet**	**Dry Wt.**	**% Dry**
Room Temp (ºC)	**Eff %**	**Transfer %**	**Eff %**	**Fuel Ratio**	**Now Wt**	**Consumed x**	**Now Wtdn**	**Comsumed y**
22.2	100.5%	80.1%	80.5%	20.4	4.85	0.00	4.07	0.00
21.1	100.4%	79.9%	80.2%	18.5	4.58	5.61	3.84	5.61
21.1	100.1%	82.3%	82.4%	14.3	4.26	12.15	3.57	12.15
20.6	99.9%	82.6%	82.5%	12.8	4.08	15.89	3.42	15.89
20.6	99.8%	83.3%	83.1%	11.0	3.86	20.56	3.23	20.56
20.6	99.4%	83.8%	83.3%	7.8	3.58	26.17	3.00	26.17
20.6	87.7%	81.9%	71.8%	6.5	3.09	36.45	2.59	36.45
20.6	92.7%	82.7%	76.7%	6.8	2.59	46.73	2.17	46.73
21.1	83.0%	81.8%	67.9%	6.0	2.09	57.01	1.75	57.01
21.1	94.1%	83.3%	78.4%	7.0	1.68	65.42	1.41	65.42
21.1	100.0%	83.0%	83.0%	10.6	1.45	70.09	1.22	70.09
21.1	100.0%	82.9%	82.9%	11.7	1.32	72.90	1.10	72.90
21.1	100.0%	83.2%	83.3%	11.6	1.18	75.70	0.99	75.70
21.1	100.0%	83.6%	83.6%	11.4	1.04	78.50	0.87	78.50
21.1	99.8%	84.2%	84.0%	9.8	0.86	82.24	0.72	82.24
21.1	100.0%	84.0%	84.0%	10.4	0.73	85.05	0.61	85.05
21.1	99.9%	84.5%	84.4%	10.4	0.64	86.92	0.53	86.92
21.1	100.1%	84.7%	84.7%	10.7	0.54	88.79	0.46	88.79
21.1	100.1%	85.0%	85.0%	11.0	0.45	90.65	0.38	90.65
21.1	100.1%	85.4%	85.5%	10.5	0.41	91.59	0.34	91.59
21.1	100.1%	85.5%	85.5%	10.6	0.32	93.46	0.27	93.46
21.1	100.1%	85.4%	85.5%	11.2	0.27	94.39	0.23	94.39
21.1	100.0%	85.5%	85.5%	11.2	0.23	95.33	0.19	95.33
21.1	100.1%	85.8%	85.9%	10.6	0.14	97.20	0.11	97.20
21.1	100.1%	85.8%	85.8%	10.9	0.09	98.13	0.08	98.13
21.1	100.1%	85.7%	85.8%	11.2	0.00	100.00	0.00	100.00

Combustion Efficiency:	96.0%		
Total Input (kJ):	80,615	76,459	(Btu)
Total Output (kJ):	64,081	60,778	(Btu)
Efficiency:	79.5%		
Total CO (g):	231.11		

Load Weight (kg):
Fuel Heating:
Value in kJ/kg - CV:

81368	4.06	6.87	2.74	19810.00	16.18	79.64	21.12	2.87
Fuel Properties					**Mw**	**Mass Balance**		
Total Input	**Carbon /12= [a]**	**Hydrogen /1= [b]**	**Oxygen /16= [c]**	**Calorific Value**	**Moisture Fuel Burnt**	**(moles/100 mole dry [h]**	**[u]**	**[w]**
0	4.06	6.87	2.74	19810.00	16.18	79.43	21.07	1.43
7157	4.06	6.87	2.74	19810.00	16.18	79.47	21.08	1.58
4144	4.06	6.87	2.74	19810.00	16.18	79.59	21.11	2.04
3390	4.06	6.87	2.74	19810.00	16.18	79.65	21.13	2.29
4144	4.06	6.87	2.74	19810.00	16.18	79.75	21.15	2.67
6404	4.06	6.87	2.74	19810.00	16.18	80.01	21.22	3.75
8288	4.06	6.87	2.74	19810.00	16.18	78.91	20.93	4.43
8288	4.06	6.87	2.74	19810.00	16.18	79.44	21.07	4.28
7534	4.06	6.87	2.74	19810.00	16.18	78.36	20.79	4.80
5274	4.06	6.87	2.74	19810.00	16.18	79.57	21.11	4.18
3014	4.06	6.87	2.74	19810.00	16.18	79.79	21.16	2.76
2260	4.06	6.87	2.74	19810.00	16.18	79.72	21.14	2.50
2260	4.06	6.87	2.74	19810.00	16.18	79.72	21.15	2.52
2637	4.06	6.87	2.74	19810.00	16.18	79.73	21.15	2.56
2637	4.06	6.87	2.74	19810.00	16.18	79.83	21.18	2.98
1884	4.06	6.87	2.74	19810.00	16.18	79.80	21.17	2.81
1507	4.06	6.87	2.74	19810.00	16.18	79.80	21.17	2.82
1507	4.06	6.87	2.74	19810.00	16.18	79.78	21.16	2.73
1130	4.06	6.87	2.74	19810.00	16.18	79.76	21.16	2.65
1130	4.06	6.87	2.74	19810.00	16.18	79.80	21.17	2.78
1130	4.06	6.87	2.74	19810.00	16.18	79.79	21.16	2.76
753	4.06	6.87	2.74	19810.00	16.18	79.75	21.15	2.61
1130	4.06	6.87	2.74	19810.00	16.18	79.74	21.15	2.61
1130	4.06	6.87	2.74	19810.00	16.18	79.79	21.17	2.77
1884	4.06	6.87	2.74	19810.00	16.18	79.77	21.16	2.69
753	4.06	6.87	2.74	19810.00	16.18	79.75	21.15	2.60

Moisture Content MCwb: 16.18

Moisture of Wood (wet basis): 16.18
Initial Dry Weight Wtdo (kg): 4.07
Moisture Content Dry 19.30

Dry kg : 4.07
CA: 48.73
HY: 6.87
OX: 43.90

4.85

HHV	LHV		HHV	LHV
19810.00	18328.69	Btu/lb	8522.48	7885.21

9.77	0.04	0.29	39.84	35.97	0.90	0.07	300.33	34.38
flue gas)		kg Wood per 100 mole dfp	Moles per kg of Dry Wood					
[j]	[k]	Nk	CO2	O2	CO	HC	N2	H2O
4.95	-0.02	0.14	40.82	103.77	0.14	-0.15	559.03	34.82
5.45	-0.02	0.16	40.81	89.95	0.13	-0.13	506.78	34.77
7.04	-0.02	0.20	40.74	59.64	0.15	-0.07	392.08	34.67
7.89	-0.01	0.23	40.64	48.45	0.22	-0.05	349.56	34.61
9.18	-0.01	0.27	40.61	35.47	0.23	-0.02	300.42	34.57
12.87	0.01	0.37	40.46	12.76	0.32	0.03	214.26	34.47
14.46	0.38	0.44	34.01	7.89	5.94	0.85	179.06	32.81
14.27	0.21	0.43	36.76	7.99	3.55	0.50	186.60	33.51
15.36	0.56	0.48	31.47	5.67	8.16	1.18	164.05	32.16
14.01	0.17	0.42	37.54	8.75	2.86	0.40	191.51	33.72
9.50	-0.01	0.27	40.74	32.75	0.11	-0.04	290.48	34.60
8.61	-0.01	0.25	40.74	40.72	0.12	-0.05	320.59	34.62
8.68	-0.01	0.25	40.74	40.06	0.12	-0.05	318.10	34.62
8.83	-0.01	0.26	40.74	38.61	0.12	-0.04	312.64	34.61
10.26	0.00	0.30	40.62	27.12	0.20	-0.01	268.91	34.55
9.68	-0.01	0.28	40.74	31.34	0.11	-0.03	285.18	34.59
9.71	-0.01	0.28	40.70	31.09	0.14	-0.03	284.14	34.58
9.41	-0.01	0.27	40.78	33.49	0.07	-0.04	293.39	34.61
9.12	-0.01	0.26	40.78	35.92	0.08	-0.05	302.60	34.62
9.56	-0.01	0.28	40.78	32.26	0.07	-0.04	288.75	34.61
9.51	-0.01	0.27	40.78	32.66	0.07	-0.04	290.28	34.61
9.00	-0.01	0.26	40.78	37.05	0.08	-0.05	306.85	34.62
8.98	-0.01	0.26	40.74	37.21	0.12	-0.04	307.36	34.61
9.53	-0.01	0.28	40.78	32.53	0.07	-0.04	289.77	34.61
9.25	-0.01	0.27	40.78	34.83	0.07	-0.05	298.47	34.61
8.97	-0.01	0.26	40.78	37.28	0.08	-0.05	307.71	34.62

10.72	389.47	3767.01	2847.34	2771.87	2740.51	3599.20	3317.95	294.20
Moisture Present	**Stack Temp K**	**Heat Content Change - Ambient to Stack Temperature Flue Gas Constituent**						**Room Temp K**
		CO2	**O2**	**CO**	**N2**	**CH4**	**H2O**	
10.72	382.59	3433.98	2602.09	2534.70	2505.69	3266.83	3034.57	295.37
10.72	391.48	3838.65	2903.82	2827.42	2795.31	3662.54	3384.63	294.26
10.72	388.15	3702.50	2802.85	2729.61	2698.51	3528.20	3267.70	294.26
10.72	392.04	3882.52	2937.01	2859.74	2827.26	3704.40	3423.31	293.71
10.72	395.93	4041.83	3054.95	2973.95	2940.31	3862.03	3559.83	293.71
10.72	416.48	4891.19	3680.61	3579.04	3539.39	4709.30	4282.86	293.71
10.72	438.71	5823.19	4361.29	4235.85	4189.99	5651.88	5067.22	293.71
10.72	433.15	5588.85	4190.70	4071.39	4027.05	5413.65	4870.87	293.71
10.72	433.15	5567.70	4174.35	4055.38	4011.25	5394.24	4851.68	294.26
10.72	424.26	5194.61	3902.00	3792.60	3750.94	5016.65	4537.88	294.26
10.72	404.26	4363.54	3291.79	3202.96	3167.06	4183.26	3833.48	294.26
10.72	397.04	4066.28	3072.32	2990.59	2956.82	3887.82	3579.67	294.26
10.72	392.59	3884.11	2937.50	2860.04	2827.60	3707.46	3423.63	294.26
10.72	388.71	3725.17	2819.67	2745.91	2714.64	3550.55	3287.18	294.26
10.72	391.48	3838.65	2903.82	2827.42	2795.31	3662.54	3384.63	294.26
10.72	389.26	3747.85	2836.50	2762.21	2730.77	3572.91	3306.67	294.26
10.72	382.59	3476.31	2634.79	2566.72	2537.31	3305.69	3072.94	294.26
10.72	377.59	3273.49	2483.78	2420.27	2392.40	3106.91	2897.82	294.26
10.72	370.93	3004.20	2282.78	2225.21	2199.42	2844.05	2664.53	294.26
10.72	367.04	2847.71	2165.71	2111.55	2086.98	2691.86	2528.57	294.26
10.72	365.37	2780.78	2115.58	2062.86	2038.82	2626.90	2470.33	294.26
10.72	363.71	2713.92	2065.48	2014.19	1990.67	2562.09	2412.10	294.26
10.72	361.48	2624.91	1998.71	1949.32	1926.51	2475.92	2334.48	294.26
10.72	360.37	2580.46	1965.34	1916.89	1894.44	2432.94	2295.69	294.26
10.72	359.26	2536.04	1931.99	1884.47	1862.37	2390.03	2256.90	294.26
10.72	358.71	2513.85	1915.31	1868.26	1846.35	2368.60	2237.51	294.26

SUMS							AVERAGE
3859.17	2488.38	6694.72	20688.68	1701.01	42254.92	13182.66	3494.98
Energy Losses (kJ/kg of Dry Fuel)							**Total**
Flue Gas Constituent							**Loss**
CO2	**O2**	**CO**	**N2**	**CH4**	**H2O Comb**	**H2O Fuel MC**	**Rate**
140.17	270.03	40.18	1400.75	-130.83	1636.45	503.99	3860.74
156.66	261.20	36.45	1416.62	-112.74	1646.72	507.74	3912.65
150.84	167.16	42.23	1058.04	-66.50	1637.76	506.49	3496.02
157.78	142.30	62.73	988.28	-41.09	1640.46	508.15	3458.62
164.14	108.34	64.64	883.32	-21.56	1643.11	509.62	3351.62
197.92	46.96	92.09	758.33	23.55	1663.24	517.37	3299.47
198.07	34.41	1707.57	750.26	764.93	1609.11	525.78	5590.13
205.45	33.49	1018.20	751.44	451.52	1636.83	523.68	4620.61
175.20	23.68	2343.73	658.05	1057.70	1570.10	523.47	6351.93
195.03	34.15	821.36	718.35	361.11	1635.45	520.11	4285.56
177.77	107.79	31.26	919.97	-32.88	1653.78	512.55	3370.24
165.66	125.09	34.50	947.93	-42.84	1646.06	509.83	3386.24
158.24	117.67	34.22	899.46	-42.01	1640.57	508.16	3316.31
151.76	108.87	33.61	848.70	-40.19	1635.66	506.70	3245.10
155.94	78.74	57.77	751.69	-12.66	1636.11	507.74	3175.33
152.69	88.90	30.64	778.76	-31.10	1635.37	506.90	3162.16
141.48	81.93	40.67	720.94	-26.15	1626.76	504.40	3090.04
133.50	83.18	20.99	701.91	-38.55	1622.01	502.52	3025.56
122.52	82.00	21.64	665.54	-41.73	1614.27	500.02	2964.26
116.13	69.86	20.63	602.61	-36.92	1609.06	498.56	2879.94
113.40	69.10	20.74	591.83	-37.45	1607.10	497.94	2862.66
110.68	76.52	21.93	610.83	-43.20	1605.69	497.31	2879.77
106.94	74.38	32.95	592.13	-38.40	1602.50	496.48	2866.98
105.24	63.93	20.69	548.94	-37.26	1601.04	496.06	2798.64
103.43	67.29	21.32	555.86	-40.28	1600.01	495.65	2803.27
102.52	71.39	21.98	568.14	-43.49	1599.67	495.44	2815.67

SUMS						
16534	3231	13302.71	64835	3231	231.11	16.09
Total Loss	**Chemical Loss 1**	**Sensible and Latent Loss**	**Total Output**	**Chem Loss 2**	**Grams Produced CO**	**HC**
0	0	0.00	0	0	0.00	0.00
1414	-28	1441.18	5744	-28	1.29	-0.73
731	-5	736.39	3412	-5	0.87	-0.25
592	4	588.30	2798	4	1.05	-0.13
701	9	692.19	3443	9	1.32	-0.08
1067	37	1029.65	5337	37	2.91	0.14
2339	1022	1316.82	5949	1022	69.64	5.72
1933	608	1325.36	6354	608	41.55	3.37
2416	1279	1137.15	5118	1279	86.95	7.19
1141	311	829.54	4133	311	21.35	1.72
513	0	512.98	2501	0	0.47	-0.09
386	-1	387.33	1874	-1	0.39	-0.09
378	-1	379.28	1882	-1	0.38	-0.09
432	-1	432.86	2205	-1	0.44	-0.10
423	6	416.74	2214	6	0.75	-0.03
301	0	300.72	1583	0	0.29	-0.05
235	1	233.96	1272	1	0.30	-0.04
230	-1	231.47	1277	-1	0.16	-0.05
169	-1	170.25	961	-1	0.12	-0.04
164	-1	165.23	966	-1	0.12	-0.04
163	-1	164.26	967	-1	0.12	-0.04
110	-1	110.33	644	-1	0.08	-0.03
164	0	163.87	967	0	0.18	-0.04
160	-1	160.60	970	-1	0.12	-0.04
267	-2	268.34	1617	-2	0.20	-0.07
107	-1	107.90	646	-1	0.08	-0.03

Dirigo Laboratories, Inc.

Manufacturer:	**Arada**
Model:	**Farringdon 16**
Date:	**2/21/2017**
Run:	**3**
Control #:	**035-S-075-1**
Test Duration:	**250**
Output Category:	**2**

	HHV Basis	LHV Basis	
Overall Efficiency	79.5%	85.9%	
Combustion Efficiency	96.0%	96.0%	
Heat Transfer Efficiency	82.8%	89.5%	
HHV Output Rate (kJ/h)	15,379	14,589	**(Btu/h)**
Burn Rate (kg/h)	0.98	2.15	**(lb/h)**
Input (kJ/h)	19,348	18,353	**(Btu/h)**
Test Load Weight (dry kg)	4.1	9.0	**dry lb**
MC wet (%)	16.18		
MC dry (%)	19.30		
Particulate (g)	8.31		
CO (g)	231		
Test Duration (h)	4.166666667		

Emissions	**Particulate**	**CO**
g/MJ Output	0.13	3.61
g/kg Dry Fuel	2.04	56.79
g/h	1.99	55.47
lb/MM Btu Output	0.30	8.38

Air/Fuel Ratio (A/F)	9.75

Test Results in Accordance with CSA B415.1-10

Default Fuel Values

	D. Fir	Oak
HHV (kJ/kg)	19,810	19,887
%C	48.73	50
%H	6.87	6.6
%O	43.9	42.9
%Ash	0.5	0.5