CTM FRM
Operation and Fueling Workgroup

Webcast

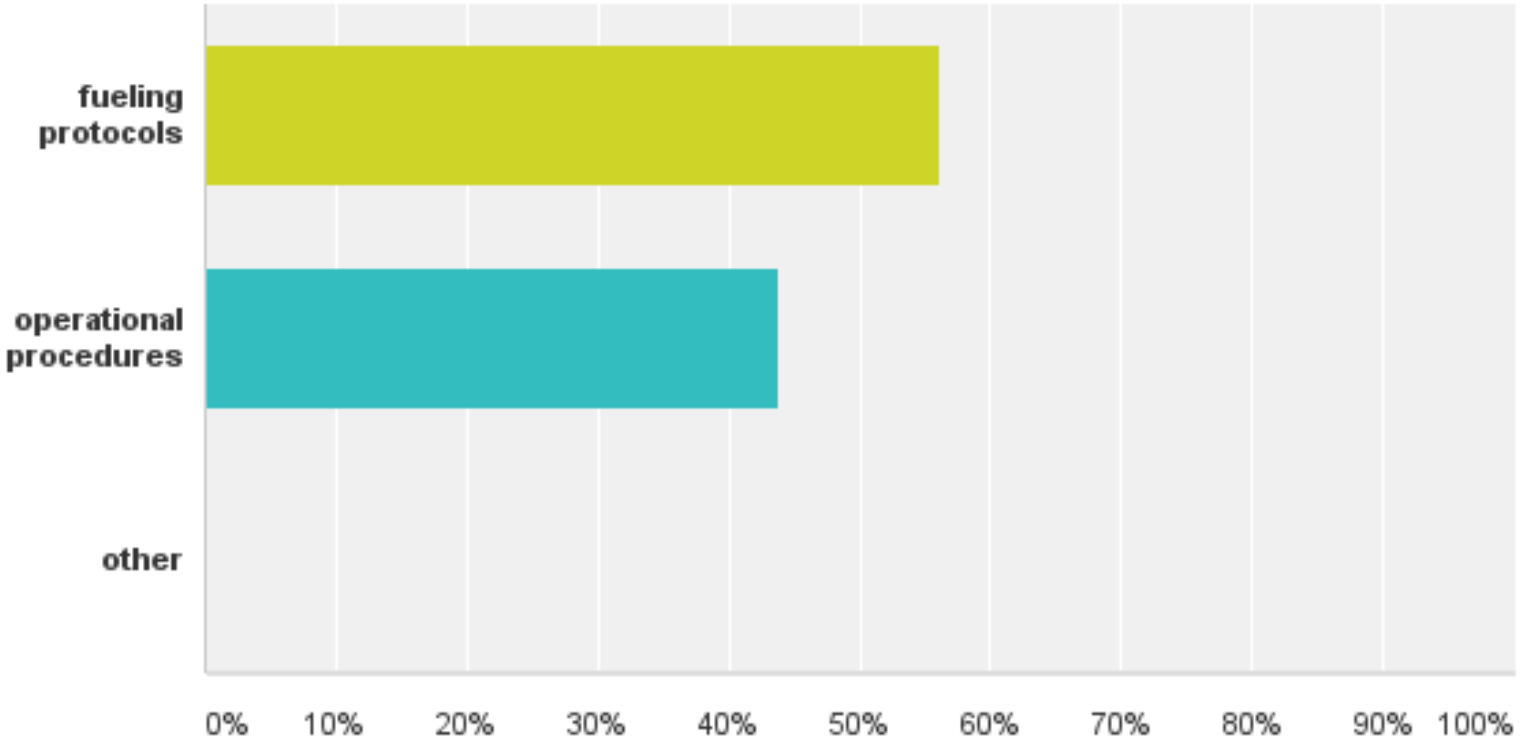
December 15, 2016

Agenda

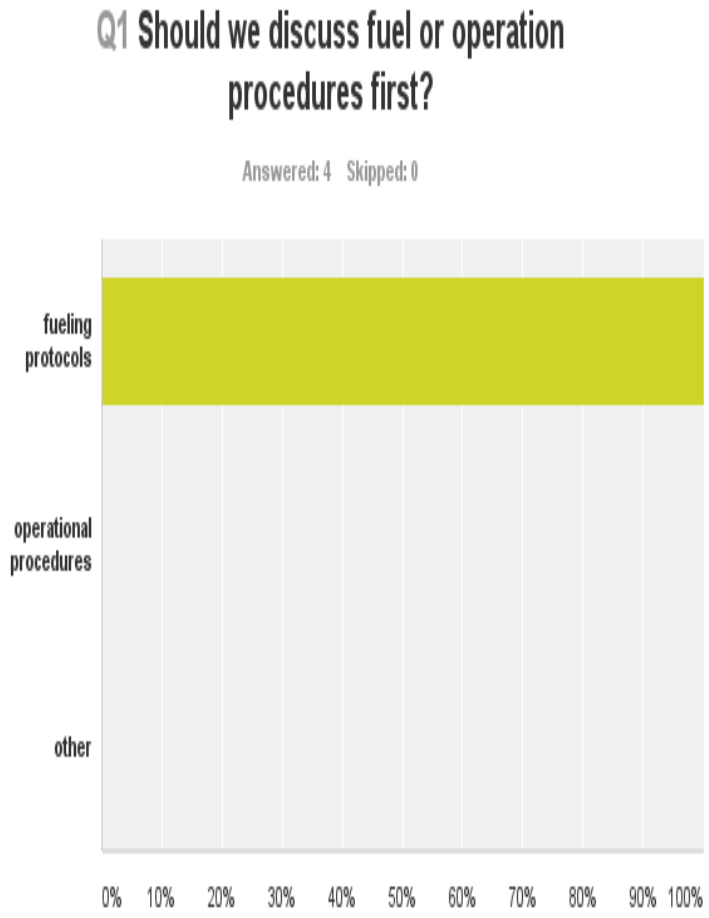
- Updates
  - Meeting schedule
- Review of survey results
- Results from EPA research
- Summary of ASTM research

Q1 Should we discuss fuel or operation procedures first?

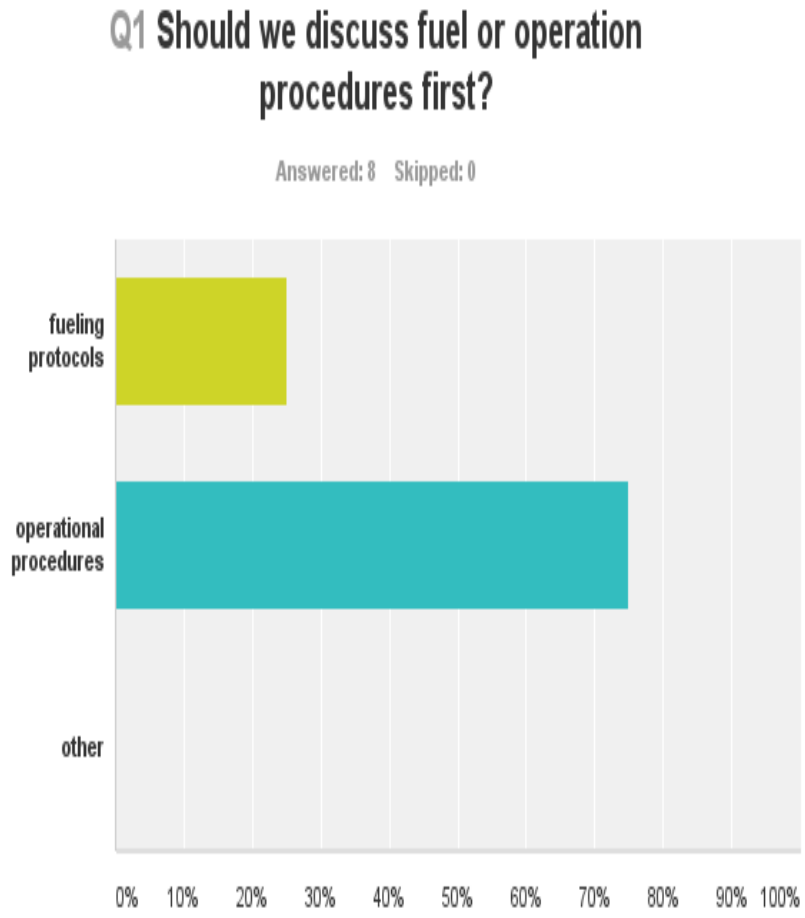
Answered: 16 Skipped: 0



Labs/industry/consultant

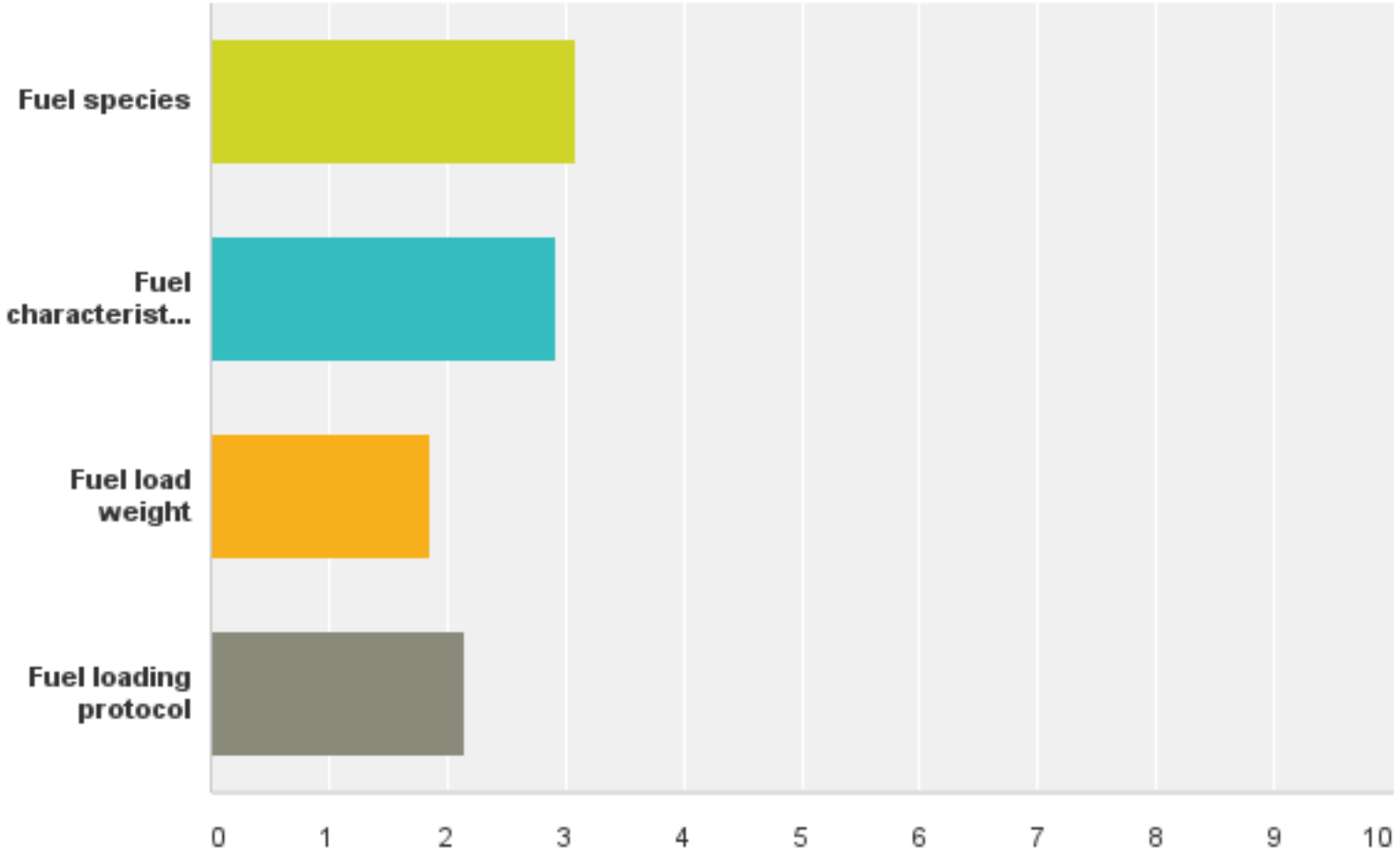


Agency Personnel



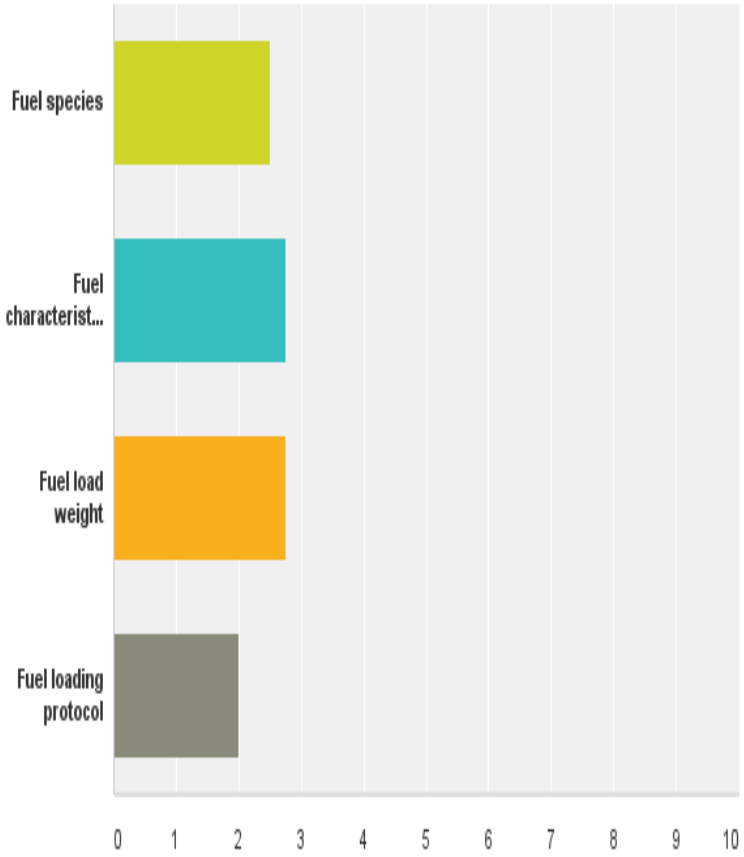
Q2 Please order the fueling elements to determine which items we should develop recommendations.

Answered: 13 Skipped: 3



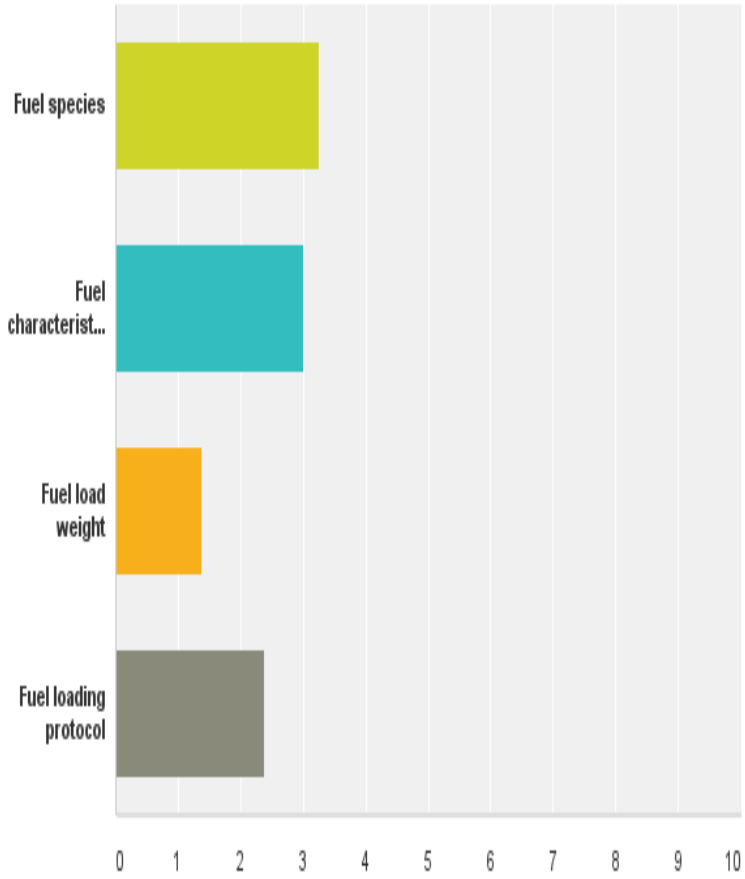
Q2 Please order the fueling elements to determine which items we should develop recommendations.

Answered: 4 Skipped: 0



Q2 Please order the fueling elements to determine which items we should develop recommendations.

Answered: 8 Skipped: 0

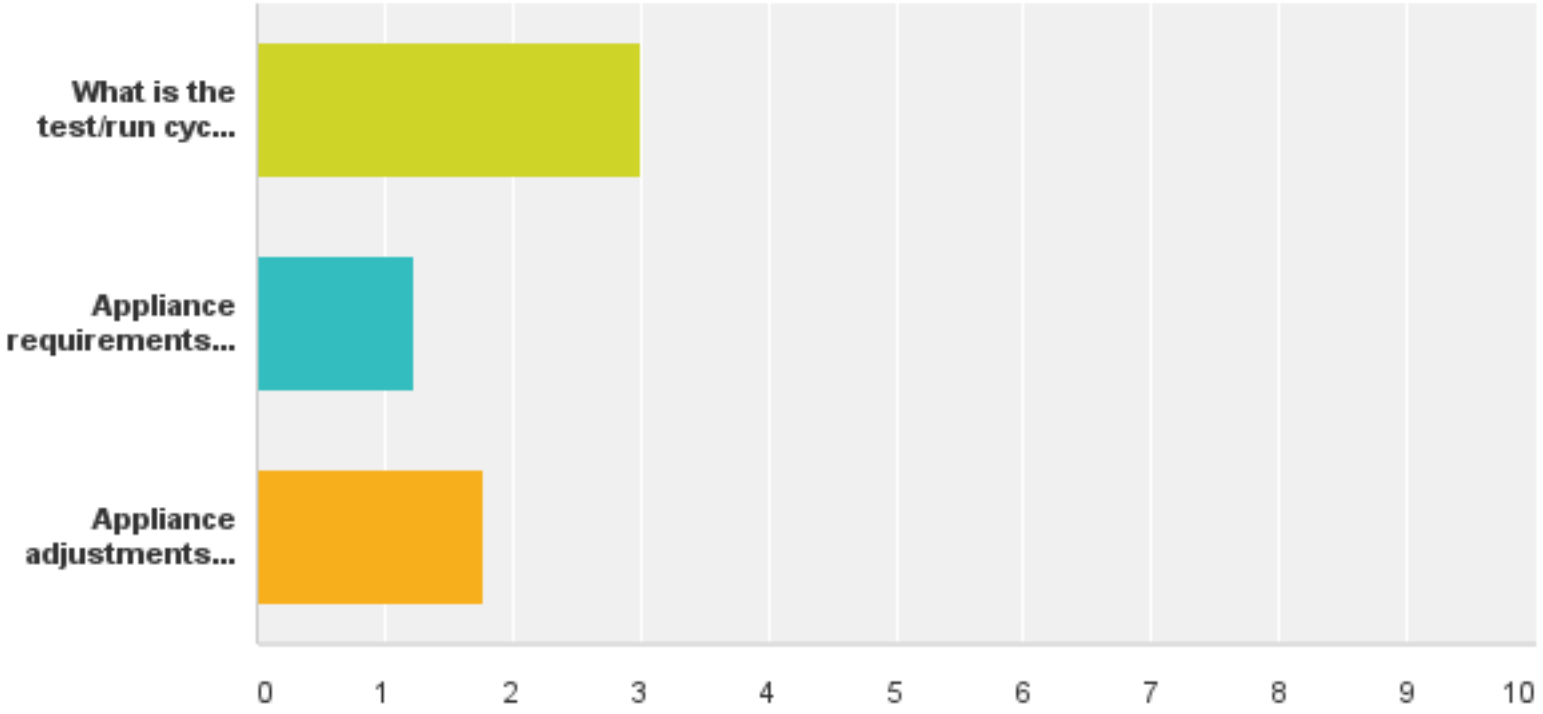


Other Fueling Issues

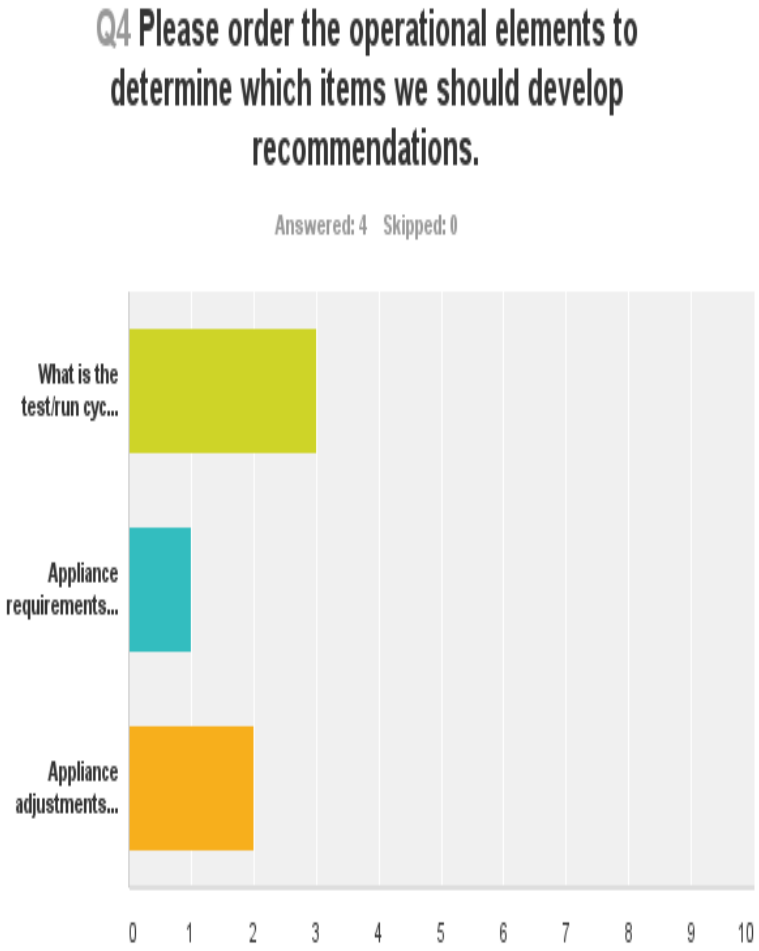
- The test should NOT prescribe a generally clean/low emission species. It should be either a higher emissions species, or both a high and low, with shorter tests and more repetitions.
- Related to fuel load weight is fuel load volume. Some folks have reported issues getting the load to fit in the stove using the draft ASTM cordwood method.
- Compare with the ASTM cordwood fueling protocol to see if we [are] missing something important
- You will have to discuss fueling first because what you decide to do in terms of fueling will then determine how the stove will be operated.
- Specific gravity v. Species Practicality in the lab Cost
- volume

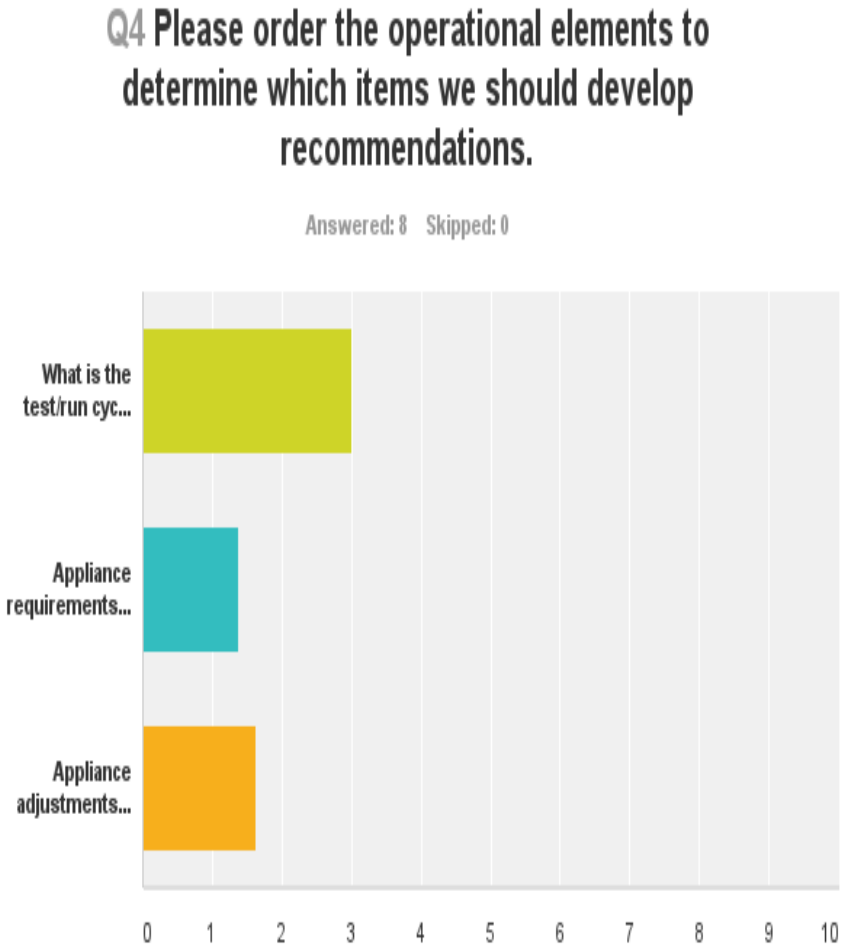
Q4 Please order the operational elements to determine which items we should develop recommendations.

Answered: 13 Skipped: 3



Order by Respondent Type





Other Operational Issues

- I think the group/process should make every effort to significantly shorten the testing time for individual tests so that more repetitions can be performed.
- Explore the application of the procedure to the many emerging designs, e.g. automated stoves, twin-chamber stoves, new designs
- End of test marker.
- Efficiency testing

EPA initial species characterization in a pre-NSPS stove

Mark Champion

December 15, 2016

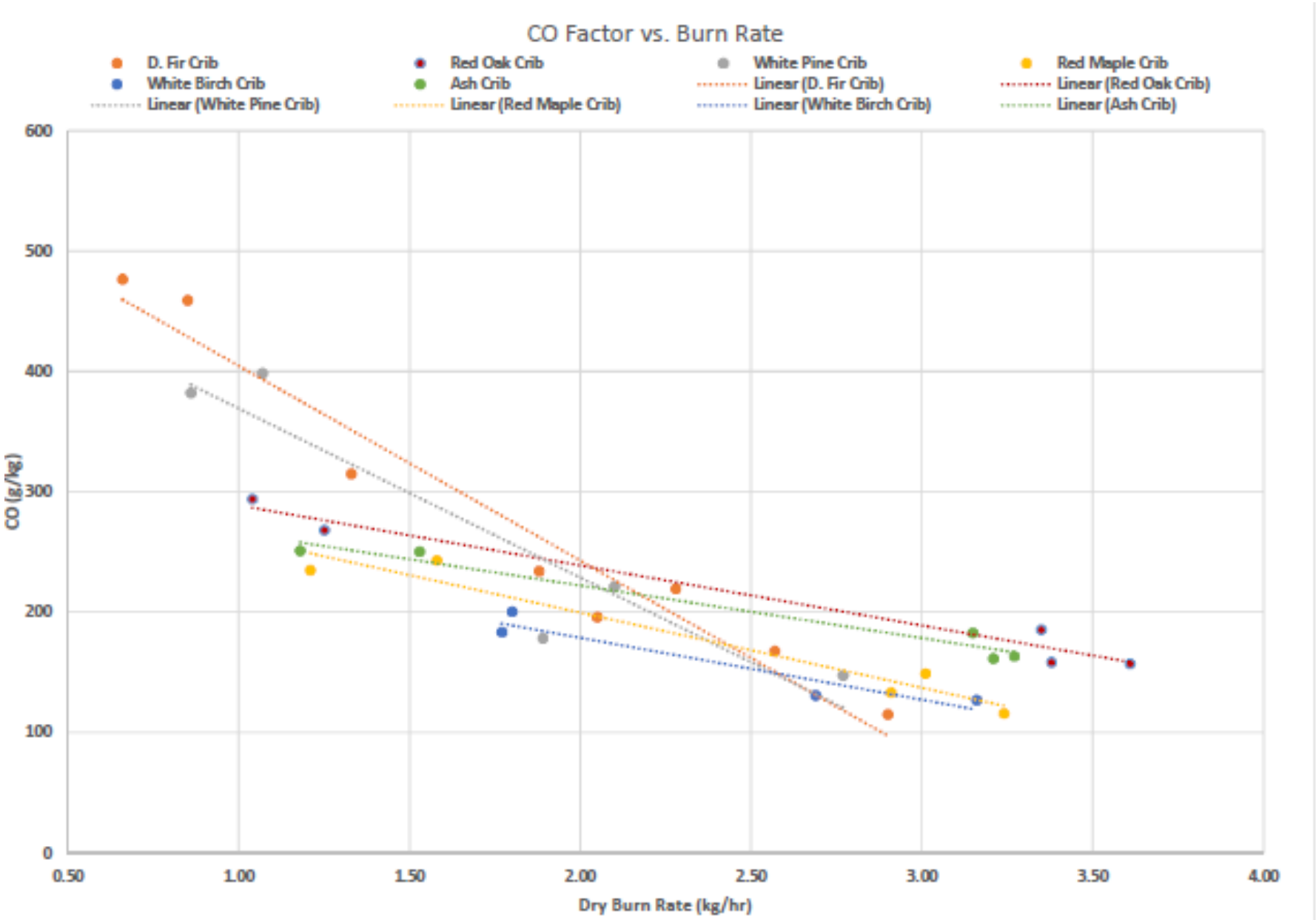
Specific Gravity Analysis, samples cut from dimensional 4x4 crib stock, all the same tree for each species

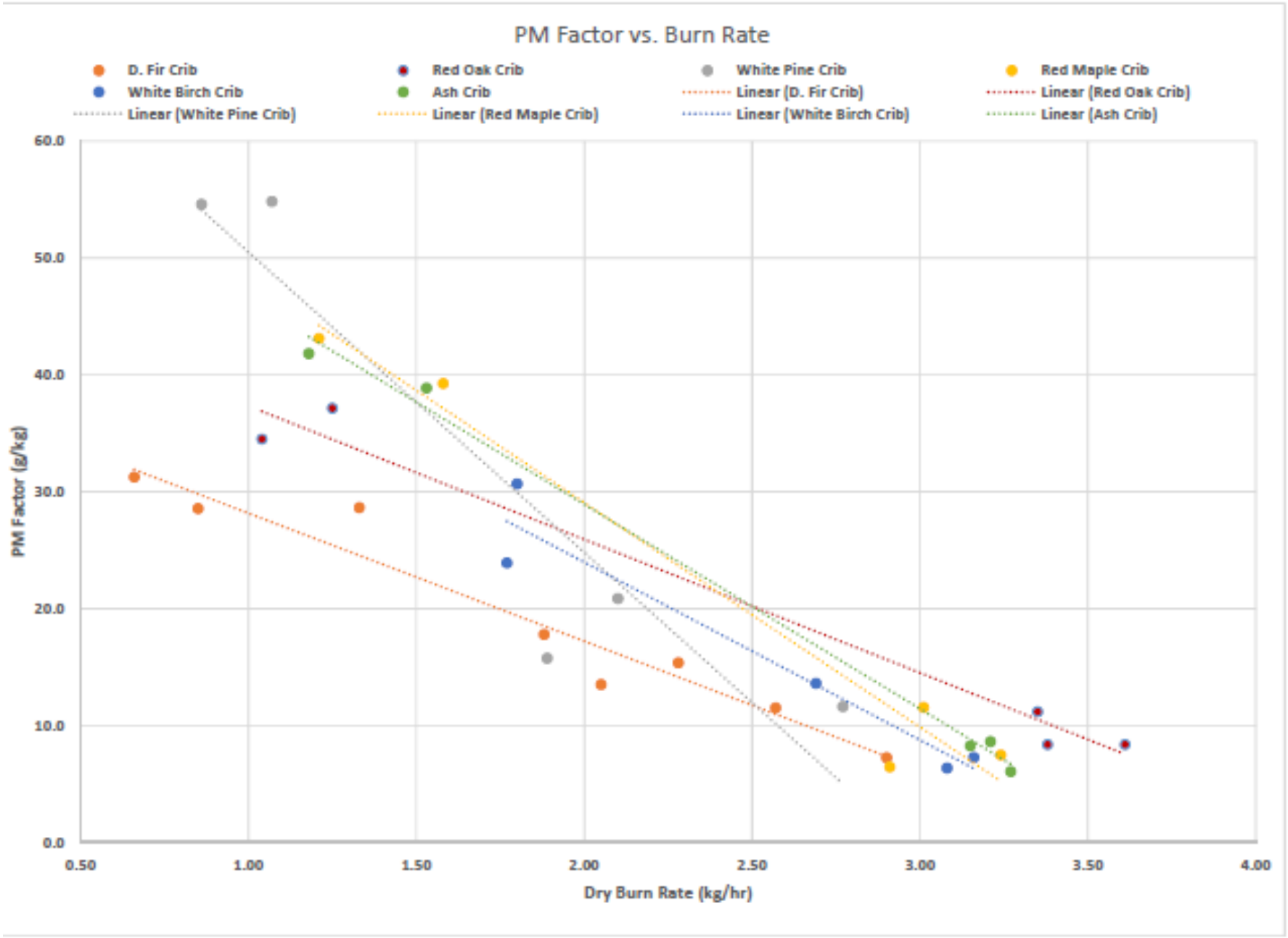
		Dry at 212 deg F to constant weight, into kiln 11/6/16						
Pc. ID	V, cc	Wet Wt, g	7-Nov	9-Nov	10-Nov	Dry Wt, g	s.g.	Average s.g.
Fir 1	1060	561	512	507	507	507	0.478	D. fir
Fir 2	1503	875	800	788	787	787	0.524	
Fir 3	1591	786	702	693	693	693	0.436	0.47
Fir 4	1865	951	850	840	839	839	0.450	
Oak 1	1150	866	780	771	771	771	0.670	Red Oak
Oak 2	1373	1013	913	902	902	902	0.657	
Oak 3	1710	1354	1198	1176	1173	1173	0.686	0.69
Oak 4	1555	1354	1187	1158	1155	1155	0.743	
Pine 1	1466	506	450	448	447	447	0.305	W. Pine
Pine 2	1522	616	529	522	522	522	0.343	
Pine 3	1181	467	425	422	422	422	0.357	0.33
Pine 4	1289	433	392	390	390	390	0.303	
Maple 1	1867	1105	936	913	912	912	0.489	Red Maple
Maple 2	1767	1074	909	886	886	886	0.501	
Maple 3	1900	1189	1003	984	983	983	0.517	0.50
Maple 4	1567	958	817	800	801	800	0.511	
Birch 1	1560	1033	825	781	781	781	0.501	White Birch
Birch 2	1611	1100	869	829	828	828	0.514	
Birch 3	1681	1082	903	881	880	880	0.524	0.52
Birch 4	1487	1017	846	828	828	828	0.557	
Ash 1	1622	1236	1021	967	966	966	0.596	Ash
Ash 2	1588	1123	921	895	894	894	0.563	
Ash 3	1761	1292	1091	1031	1029	1029	0.584	0.58
Ash 4	1694	1197	1020	979	978	978	0.577	

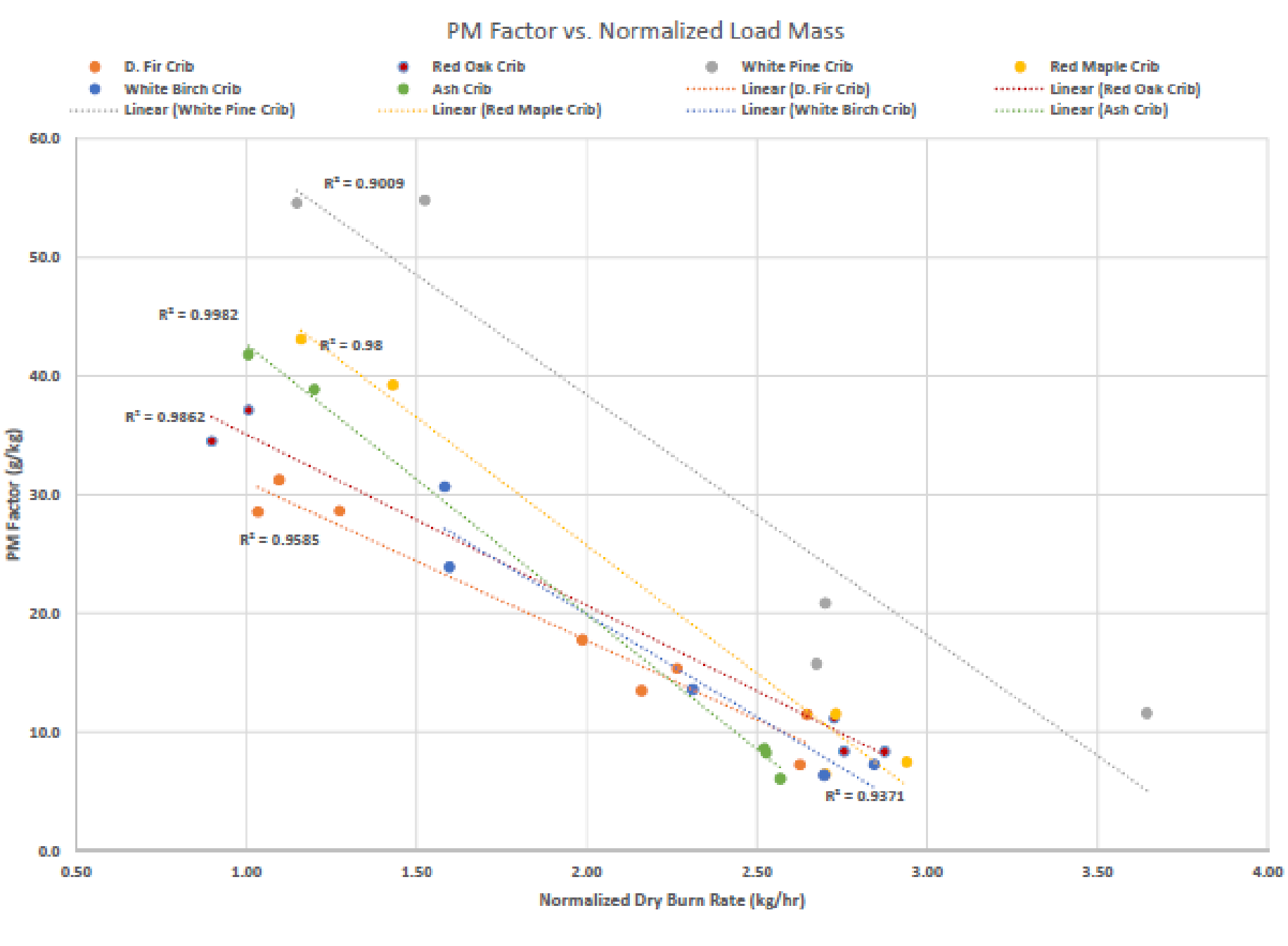

ASH 3
MAPLE 1
MAPL #3
ASH 4
FIR 4
MAPLE 4
BIRCH 2
ASH 2
OAK 1
PINE 4
FIR 1
OAK 4
OAK 2

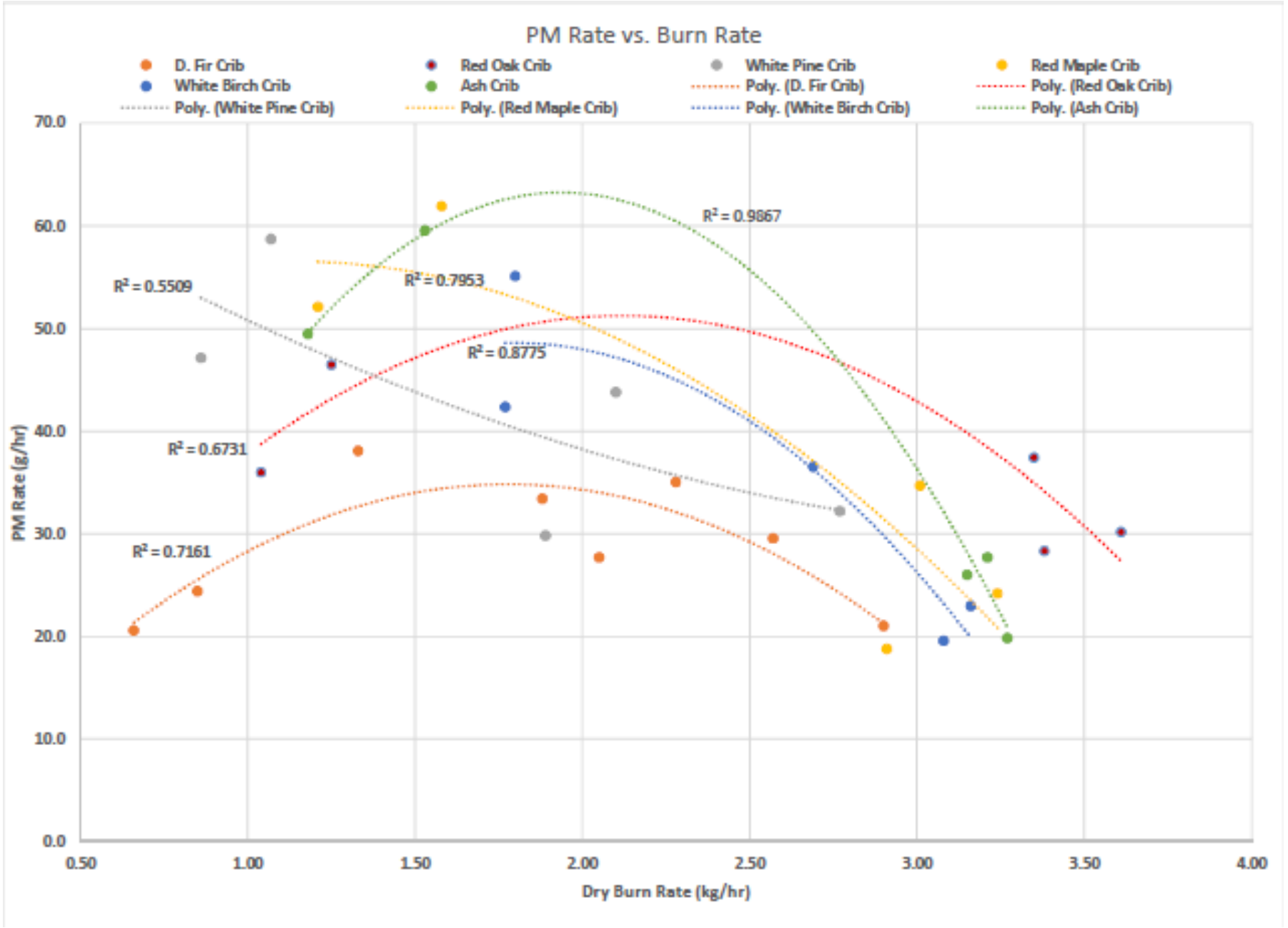

MAPLE
RED OAK
ASH
WHITE BIRCH

File	Fuel	Test Setting	PM, g/hr	PM, g/kg	CO, g/kg	Burn Rate, dry kg/hr	Train 1 time 0 front catch, mg	Train 2 time 0 front catch, mg	Final PM Precision, %
Vig1608161	D. fir crib	high	27.7	13.5	196	2.05			
Vig1608211	D. fir crib	high	33.4	17.8	234	1.88	54.1	53.9	1.4
Vig1608231	D. fir crib	high	29.5	11.5	168	2.57	34.1	34.2	0.3
Vig1608251	D. fir crib	high	35.1	15.4	220	2.28	33.8	34.8	1.9
Vig1608271	D. fir crib	Low	24.4	28.6	459	0.85	54.4	56.6	0.0
VigOak1608311	Red oak crib	high	37.4	11.2	186	3.35	29.0	28.2	2.6
VigOak1609011	Red oak crib	high	30.1	8.4	158	3.61	21.1	21.0	0.1
Vig1609031	D. fir crib	low	38.1	28.6	315	1.33	66.8	63.4	3.8
Vig1609101	D. fir crib	high	21.0	7.3	115	2.90	17.2	17.5	0.4
Vig1609201	D. fir crib	low	20.6	31.3	477	0.66	44.3	44.2	3.4
VigOak1609211	Red oak crib	high	28.3	8.4	159	3.38	21.3	21.6	1.9
VigOak1609221	Red oak crib	low	36.0	34.5	294	1.04	68.6	67.9	3.7
VigOak1609271	Red oak crib	low	46.5	37.2	268	1.25	106.5	104.4	0.7
VigWPine1610151	White Pine crib	high	32.2	11.6	148	2.77	17.1	17.1	3.0
VigWPine1610152	White Pine crib	high	43.8	20.9	222	2.10	34.3	32.9	0.9
VigWPine1610161	White Pine crib	low	47.1	54.6	382	0.86	92.2	90.4	0.8
VigWPine1610181	White Pine crib	low	58.7	54.8	399	1.07	88.5	86.8	0.8
VigWPine1610211	White Pine crib	high	29.8	15.8	179	1.89	25.0	23.9	2.8
VigMaple1610301	Red Maple Crib	high	34.7	11.6	149	3.01	26.4	25.9	0.1
VigMaple1610302	Red Maple Crib	high	24.2	7.5	116	3.24	16.6	16.2	1.2
VigMaple1610311	Red Maple Crib	low	52.1	43.1	235	1.21	99.6	98.1	0.3
VigWBirch1611031	White Birch Crib	high	36.5	13.6	131	2.69	32.9	31.7	0.4
VigWBirch1611051	White Birch Crib	low	55.1	30.7	201	1.80	78.3	73.3	3.7
VigMaple1611061	Red Maple Crib	low	61.9	39.3	243	1.58	91.8	91.8	0.4
VigWBirch1611071	White Birch Crib	high	23.0	7.3	127	3.16	15.5	15.6	1.4
VigMaple1611151	Red Maple Crib	high	18.8	6.4	134	2.91	13.6	13.6	2.5
VigAsh1611161	Ash Crib	high	27.7	8.6	162	3.21	21.7	21.5	2.8
VigAsh1611171	Ash Crib	high	26.0	8.3	183	3.15	19.8	20.1	0.5
VigAsh1611191	Ash Crib	low	59.5	38.9	251	1.53	106.1	108.6	1.4
VigWBirch1611201	White Birch Crib	low	42.4	23.9	184	1.77	56.2	56.8	0.7
VigWBirch1611221	White Birch Crib	high	19.6	6.3	113	3.08	14.5	14.3	0.4
VigAsh1611261	Ash Crib	low	49.5	41.8	252	1.18	106.2	106.7	0.4
VigAsh1611301	Ash Crib	high	19.8	6.1	164	3.27	14.6	14.8	0.4


CO Factor vs. Burn Rate
D. Fir Crib
Red Oak Crib
White Pine Crib
Red Maple Crib
White Birch Crib
Ash Crib
Linear (D. Fir Crib)
Linear (Red Oak Crib)
Linear (White Pine Crib)
Linear (Red Maple Crib)
Linear (White Birch Crib)
Linear (Ash Crib)
CO (g/kg)
Dry Burn Rate (kg/hr)
0
100
200
300
400
500
600
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00


PM Factor vs. Burn Rate
D. Fir Crib
Red Oak Crib
White Pine Crib
Red Maple Crib
White Birch Crib
Ash Crib
Linear (D. Fir Crib)
Linear (Red Oak Crib)
Linear (White Pine Crib)
Linear (Red Maple Crib)
Linear (White Birch Crib)
Linear (Ash Crib)
PM Factor (g/kg)
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
Dry Burn Rate (kg/hr)


PM Factor vs. Normalized Load Mass
D. Fir Crib
Red Oak Crib
White Pine Crib
Red Maple Crib
White Birch Crib
Ash Crib
Linear (D. Fir Crib)
Linear (Red Oak Crib)
Linear (White Pine Crib)
Linear (Red Maple Crib)
Linear (White Birch Crib)
Linear (Ash Crib)
R² = 0.9009
R² = 0.9982
R² = 0.98
R² = 0.9862
R² = 0.9585
R² = 0.9371
PM Factor (g/kg)
Normalized Dry Burn Rate (kg/hr)
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00


PM Rate vs. Burn Rate
D. Fir Crib
Red Oak Crib
White Pine Crib
Red Maple Crib
White Birch Crib
Ash Crib
Poly. (D. Fir Crib)
Poly. (Red Oak Crib)
Poly. (White Pine Crib)
Poly. (Red Maple Crib)
Poly. (White Birch Crib)
Poly. (Ash Crib)
R² = 0.9867
R² = 0.7953
R² = 0.8775
R² = 0.5509
R² = 0.6731
R² = 0.7161
PM Rate (g/hr)
Dry Burn Rate (kg/hr)
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00