

#### Checking for Differences between Stands within a Lab (T11)

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## Checking for Differences between Stands within a Lab **Executive Summary:**

- Analysis of all Chartable data with Reference Oils 820-2, 820-3, 822-1, and 822-2 indicates that there are no significant differences between stands within a Laboratory
- Analysis of Chartable Reference Oils 822-1 and 822-2 data suggests that there are significant differences between stands within a Test Laboratory
  - Soot4 Parameter: [A]14 > [A]7
  - MRV Parameter: [A]7>[A]14
  - Removal of Test Key 98616-T11 results is no significant difference between Stands within a Lab for Soot4 & MRV is marginally significant (p=0.068)



## Checking for Differences between Stands within a Lab

#### Objective: Determine if there are differences between stands within a Lab

- Significant differences between stands within a Lab would suggest a Lab-Stand based LTMS (as compared to the current Lab based LTMS system)
- Pass/Fail variables analyzed:
  - Soot4
  - Soot(@12cSt)
  - Soot15
  - MRV
- ▲ Analysis *"Data Set 1"*:
  - Analyze all available T11 Chartable test results
- ▲ Analysis *"Data Set 2"*:
  - Analyze all Chartable T11 test results with current reference oil blends 822-1, and 822-2





#### T11 - Analysis Data Set 1 (All Chartable Data)

# Passion for Solutions.

#### Analysis of Soot4 parameter is shown below

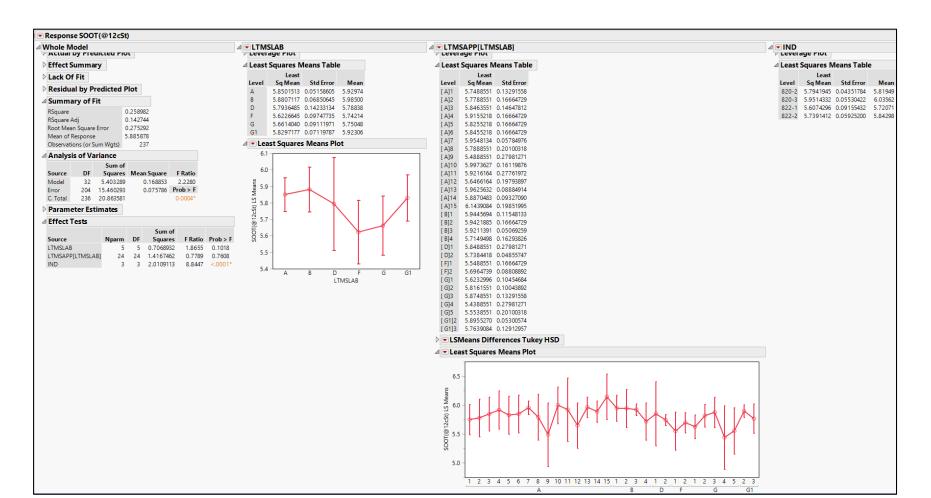
- Significant differences between Labs
- No significant difference between Stands within a Lab
  - Significant differences are stands between Labs

Response SOOT4								
Whole Model								
Actual by Predicted Plot	▷ Leverage Plot	▷ Leverage Plot	Leverage Plot					
Effect Summary	⊿ Least Squares Means Table	⊿ Least Squares Means Table	Least Squares Means Table					
⊿ Lack Of Fit	Least	Least	Least					
Source         DF         Sum of Squares         Mean Square         F Ratio           Lack OF Fit         13         1.1391603         0.087628         1.6620           Pure Error         114         7.4341521         0.05274         Prob > F           Total Error         154         8.5733125         0.0755         Max RSq           0.4417         Composition         0.356162         0.4417           RSquare Adj         0.235947         0.4417           Mean Square Error         0.235947         0.4417           Mean Square Error         0.235947         0.235947           Mean of Response         3.921404         0           Observations (or Sum Wgts)         178           Analysis of Variance         Sum of Squares         9.206202           Fror         154         8.573312         0.055671           Frods         157         13.315949         <.0001*	Level         Sq Mean         Std Error         Mean           A         3.9256406         0.05471570         3.918855           B         4.1013810         0.08421160         4.06538           D         3.9094031         0.04365670         3.90545           F         3.817795         0.08223423         3.66889           G         3.8102767         0.01097057         3.71111           G1         3.7263037         0.06159752         3.84944           Image: Constraint of the state of the sta	Level         Sq Mean         Std Error           [A]7         3.8417250         0.05369637           [A]8         3.9127767         0.17378657           [A]9         4.3227767         0.24090911           [A]10         3.9334467         0.13819896           [A]11         3.6637617         0.24090911           [A]12         3.7537817         0.16979480           [A]12         3.7537817         0.16979480           [A]13         3.954493         0.04556835           [A]14         4.1435180         0.08030304           [A]15         3.8004884         0.17039882           [B]1         4.2227767         0.2490911           [B]3         4.0128555         0.04354264           [B]4         4.3317151         0.13826774           [B]3         4.0128555         0.04354264           [B]4         4.3317151         0.13826770           [F]2         3.8577765         0.24090911           [G]3         3.9227767         0.24090911           [G]5         3.6277767         0.12760900           [G]4         3.9227767         0.24090911           [G]5         3.6277767         0.24090911           [G]	Level         Sq Mean         Std Error         Ma           820-2         3.8056874         0.04630316         3.822           820-3         3.9746824         0.04169678         3.422           822-1         3.9605109         0.07528322         4.055           822-2         3.8129758         0.04676498         3.81					
Effect Tests	3.5 A B D F G G1	Least Squares Means Plot						
Source         Nparm         DF         Squares         F Ratio         Prob>           LTMSLAB         5         5         0.8829644         3.1721         0.0094           LTMSAPP[LTMSLAB]         15         1.5         1.7231026         2.0634         0.0144           IND         3         3         0.9171829         5.4917         0.0013	•	Least Squares Means Plot						

ITMSLAB / ITMSA

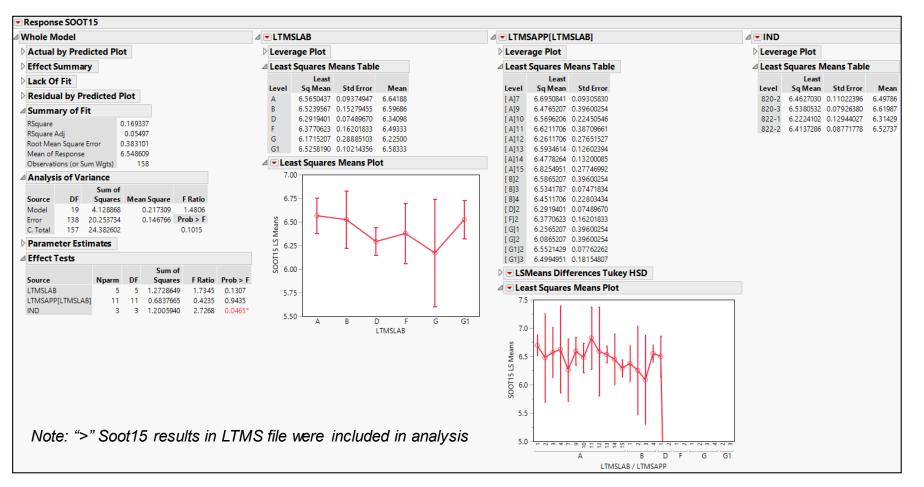
#### Analysis of Soot(@12cSt) parameter is shown below

- ▲ Marginally significant difference between Labs (p~0.10)
- No significant difference between Stands within a Lab



#### Analysis of Soot15 parameter is shown below

- No Significant difference between Labs
- No significant difference between Stands within a Lab



#### Analysis of MRV parameter is shown below

- Significant difference between Labs
- No significant difference between Stands within a Lab

Whole Model	ITMSL	AB				SAPP[LTM	SLAB]					
Actual by Predicted Plot	D Leverag	ae Plot				age Plot			Levera	nge Plot		
Effect Summary		-	leans Tabl	e		-	eans Table			-	leans Tabl	
Lack Of Fit		Least				Least				Least		
Residual by Predicted Plot		Sq Mean	Std Error	Mean	Level	Sq Mean	Std Error			Sq Mean	Std Error	Mear
Summary of Fit		14499.642 14500.210	207.51079 275.57501	14609.9 14528.2	[ A]1 [ A]2	15180.488 14240.488	534.6681 670.3577		820-2 820-3	15383.001 14933.806	175.05547 222.46753	15308.5
RSquare 0.281146	D	15127.054	572.54407	14678.1	[A]3	15215.488	589.2250		822-1	14610.647	368.28771	139604
RSquare Adj 0.168384		15706.229	392.11379	15833.4	[A]4	14373.821	670.3577		822-2	14766.503	238.34793	144362
Root Mean Square Error 1107.394		14582.773 15125.028	366.53944 286.40155	15407.7 14802.7	[A]5 [A]6	15473.821 14573.821	670.3577 670.3577					
Mean of Response 14797.12	01	13123.028	280.40133	14002.7	[ A]7	14749,444	232.7073					
Observations (or Sum Wgts) 237					[A]8	13533.988	808.5582					
Analysis of Variance					[A]9		1125.5786					
Sum of Source DF Squares Mean Square F Ratio					[A]10 [A]11		648.4404 1116.7570					
Model 32 97841920 3057560 2.4933					[A]12		796.2321					
Error 204 250169569 1226321 Prob > F					[A]13	13913.967	357.4058					
C. Total 236 348011489 <.0001*					[A]14	13509.171	375.1929					
Parameter Estimates					[A]15		798.5692					
⊿ Effect Tests					[B]1 [B]2	14833.060 14459.155	464.5368 670.3577					
Sum of					[ B]3	14329.611	203.9167					
Source Nparm DF Squares F Ratio Prob >					[B]4	14379.016	655.4378					
LTMSLAB 5 5 15220413 2.4823 0.0330					[D]1	15647,488	1125.5786					
LTMSAPP[LTMSLAB] 24 24 34115116 1.1591 0.283 IND 3 3 6871489 1.8678 0.1362					[D]2 [F]1	14606.619 16007.155	195.3280 670.3577					
IND 5 5 06/1409 1.60/6 0.150	<u>-</u>				[F]2	15405.304	354.3478					
					[G]1	14832.710	420.5516					
					[G]2	14952.188	404.0270					
					[G]3	15680.488	534.6681					
					[G]4 [G]5	12714.488 14733.988	808.5582					
					[ G1]2		213.2216					
						15432.986						
					D 💌 LS	Means Diff	erences Tukey HSD					
							Means Plot					
					19	000						
					18	000 -						
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						1 2	A B D F	1 2 3 4 5 2 3 G G1				



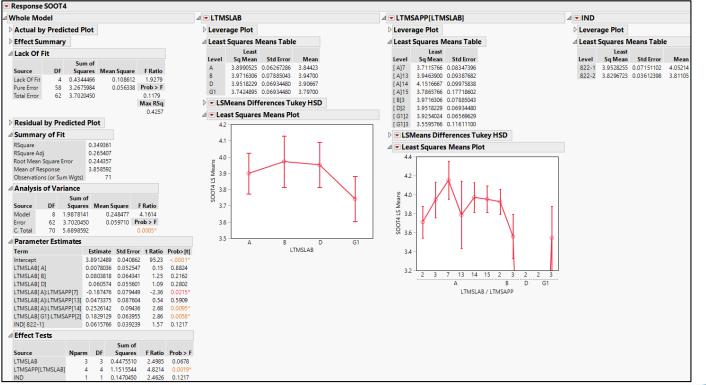


#### T11 - Analysis Data Set 2 (Chartable with RO's 822-1, and 822-2)

# Passion for Solutions.

#### Analysis of Soot4 parameter is shown below

- Significant differences between Labs
- Significant difference between Stands within a Lab
  - [A]14>[A]7





### Analysis of Soot(@12cSt) parameter is shown below

- ▲ Marginally significant difference between Labs (p~0.10)
- No significant difference between Stands within a Lab

Response SOOT (@12cSt)			
Whole Model			⊿ <b>▼IND</b>
Actual by Predicted Plot	Leverage Plot	▷ Leverage Plot	Leverage Plot
Effect Summary	Least Squares Means Table	Least Squares Means Table	Least Squares Means Table
Lack Of Fit	Least	Least	Least
Residual by Predicted Plot	Level         Sq Mean         Std Error         Mean           A         5.9248255         0.09859928         5.95000	Level Sq Mean Std Error [ A17 5.9822082 0.13132435	Level Sq Mean Std Error Mean 822-1 5.6991951 0.11250381 5.72071
	B 5.8195196 0.12405043 5.84300	[A]7 5.9822082 0.13132435 [A]13 5.8591282 0.14769051	822-1 5.6991951 0.11250381 5.72071 822-2 5.8165969 0.05683160 5.84298
⊿ Summary of Fit	D 5.5496194 0.10909583 5.59267	[A]14 5.8066667 0.15694360	022-2 5.8105909 0.05085100 5.84298
RSquare 0.155834	G1 5.7376194 0.10909583 5.80600	[A]15 6.0512991 0.27875565	
RSquare Adj 0.046909		[B]3 5.8195196 0.12405043	
Root Mean Square Error 0.384432	Least Squares Means Plot	[D]2 5.5496194 0.10909583	
Mean of Response 5.818873	6.2	[G1]2 5.8039396 0.10335585	
Observations (or Sum Wgts) 71	6.1 – T	[G1]3 5.6712991 0.18267016	
Analysis of Variance		LSMeans Differences Tukey HSD	
Sum of	sueaw 5.9 - State of the state		
Source DF Squares Mean Square F Ratio	₩ 5.9 -	Least Squares Means Plot	
Model 8 1.691469 0.211434 1.4307 Error 62 9.162841 0.147788 Prob > F	ਹ <sup>2</sup>	6.75	
Error 62 9.162841 0.147788 Prob > F C. Total 70 10.854310 0.2018	δ <sup>3</sup>	δ	
	₩ 5.7 -	6.50 -	
⊿ Parameter Estimates	Ĕ 5.6-	aus	
Term Estimate Std Error t Ratio Prob> t		¥ ₩ 6.25 - 1	T
Intercept 5.757896 0.064286 89.57 <.0001*	5.5 -		
LTMSLAB[A] 0.1669296 0.082668 2.02 0.0478*	5.4 -	र्च 6.00 - 🔥 📔 🕂 Т	
LTMSLAB[B] 0.0616237 0.101224 0.61 0.5449			
LTMSLAB[ D] -0.208277 0.087473 -2.38 0.0203*	5.3 A B D (	31 \$3 6.00 - (a) 5.75 - (b) 5.75 -	
LTMSLAB[A]:LTMSAPP[7] 0.0573827 0.124991 0.46 0.6478	LTMSLAB	8 5.75	
LTMSLAB[A]:LTMSAPP[13] -0.065697 0.137822 -0.48 0.6353			
LTMSLAB[A]:LTMSAPP[14] -0.118159 0.14845 -0.80 0.4291 LTMSLAB[G1]:LTMSAPP[2] 0.0663202 0.100616 0.66 0.5122		5.50 - 1 1	
IND[ 822-1] -0.058701 0.061732 -0.95 0.3453			
		5.25 2 3 7 13 14 15 2 3 2 2	3
△ Effect Tests		A B D	G1
Source Nparm DF Squares F Ratio Prob >	e	LTMSLAB / LTMSAPP	
LTMSLAB 3 3 1.1815168 2.6649 0.0556			
LTMSLAB 5 5 1.1815108 2.0049 0.0550 LTMSAPP[LTMSLAB] 4 4 0.2370055 0.4009 0.8072			
IND 1 1 0.1336312 0.9042 0.3453			



#### Analysis of Soot15 parameter is shown below

- Significant differences between Labs
- No significant difference between Stands within a Lab

<ul> <li>Response SOOT15</li> </ul>																
Whole Model							4		SAPP[LTN	/ISLAB]						
Actual by Predicte	Leverage Plot					▷ Leverage Plot			Leverage Plot							
Effect Summary			⊿ Least Squares Means Table					⊿ Least	Squares I	Means Table	Least Squares Means Table					
Lack Of Fit			Laural	Least Sg Mean	Std Error	Mean		Laural	Least	Std Error	Laural	Least Sg Mean	Std Error	Mean		
Residual by Predi	cted Plot		Level A	6.5919676		6.64731		Level [ A]7		0.17685799	Level 822-1		0.15151187	6.31429		
⊿ Summary of Fit			В	6.4324175		6.46700		[A]13		0.19889873	822-2		0.07653662			
-	0.171391		D	6.1065987	0.14692224	6.17000		[A]14	6.4066667	0.21136011						
RSquare			G1	6.4515987	0.14692224	6.52050		[A]15	6.7435437	0.37540764						
RSquare Adj	0.064474			st Squares	Moone DL	ot		[ B]3	6.4324175	0.16706201						
Root Mean Square Error	6.485352			•	ivicalis Fi	01		[D]2	6.1065987	0.14692224						
Mean of Response Observations (or Sum V			7.0					[G1]2	6.4856537	0.13919207						
	2 ·		6.8	т				[G1]3	6.4175437	0.24600675						
Analysis of Varian			0.0		Т		т	⊳ <b>– LS</b> I	Means Dif	ferences Tukey HSD						
	um of	<b>B</b>	6.6	-					et Square	s Means Plot						
		Ratio	6.6 Weaus						ist Square	s Means Flot						
		.6030 b > F	≚ 6,4			т										
		1423	~	<u>+</u>		$\setminus$ $\mid$ $>$		7.5	-							
C. Total 70 20.0		1423	£ 6.2	-												
Parameter Estima	tes		5100S			$\vee$	-		-							
Term	Estimate Std Error	t Ratio Prob> t	6.0	-				2.0 SoOT15 LS Means	T							
Intercept	6.3956456 0.086575	73.87 <.0001*						еа Ме	-							
LTMSLAB[ A]	0.1963219 0.111332	1.76 0.0828	5.8	-		-		S	161	Tar T						
LTMSLAB[ B]	0.0367719 0.136321	0.27 0.7883						-15								
LTMSLAB[ D]	-0.289047 0.117803	-2.45 0.0170*	5.6	Δ	В	D	G1	Q 6.5								
LTMSLAB[ A]:LTMSAPP		0.93 0.3545		Ŷ		TMSLAB	01	S		¶   % r ∕   ¶						
LTMSLAB[ A]:LTMSAPP	[13] -0.123306 0.185608	-0.66 0.5089			-											
LTMSLAB[ A]:LTMSAPP		-0.93 0.3576														
LTMSLAB[G1]:LTMSAP		0.25 0.8024						6.0	-							
IND[ 822-1]	-0.086456 0.083136	-1.04 0.3024								L						
⊿ Effect Tests									2 3	7 13 14 15 2 3 2 2 A B D G						
	Sum of									LTMSLAB / LTMSAPP						
	Iparm DF Squares	F Ratio Prob > F								EnviseAb / EnviseEF						
LTMSLAB	3 3 1.9892957	2.4739 0.0698														
LTMSAPP[LTMSLAB]	4 4 0.5967811	0.5566 0.6949														
IND	1 1 0.2898756	1.0815 0.3024														



#### Analysis of MRV parameter is shown below

- Significant differences between Labs
- Significant difference between Stands within a Lab
  - [A]7>[A]14

Response MRV																	
A Whole Model			⊿ <b>▼LTM</b>	SLAB				APP[LTM	SLAB]	⊿ ⊂ IN	⊿ <b>▼IND</b>						
Actual by Predicted Plot				▷ Leverage Plot				Lever	age Plot		▷ Lev	Leverage Plot					
Effect Summary						⊿ Least	Squares N	leans Tabl	e	⊿ Least	Squares N	leans Table		⊿ Lea	st Squares M	leans Tabl	e
Lack Of Fit	_						Least				Least		_		Least		
Residual by Pred	licted	Plot				Level A	Sq Mean 14031.506	Std Error 254.52560	Mean 14148.3	Level [A]7	Sq Mean 15025.638	Std Error 339.00254		Leve 822			Mean 13960.4
⊿ Summary of Fit						B	14248.401	320.22555	14246.0	[A]13		381.25038		822			14436.2
RSquare RSquare Adj Root Mean Square Err Mean of Response Observations (or Sum	or	0.279086 0.186065 992.3776 14342.41 71				D G1	14429,401 14817.068	281.62151 281.62151	14425.0 14581.0	[A]14 [A]15 [B]3 [D]2 [G1]2 [G1]3	12972.667 14412.002 14248.401 14429.401 14352.134 15282.002	405.13644 719.58381 320.22555 281.62151 266.80427 471.54724					
Analysis of Varia	ince											erences Tuk					
	Sum o												-				
	Square: 363743	s Mean S		Ratio .0002						⊿ <u>► Lea</u> 165	•	Means Plot					
	303743 105841		954679 3 984813 Pro										T				
C. Total 70 8	469585	1	0.	0066*						160		T					
Parameter Estim	ates									155	600 -						
Term Intercept LTMSLAB[A] LTMSLAB[B] LTMSLAB[D] LTMSLAB[A]:LTMSAF	P[7]	14381.594 -350.0884 -133.1932 47.807477 994.13281	Std Error 165.9477 213.4015 261.3011 225.8052 322.6544	86.66 -1.64 -0.51 0.21 3.08	<.0001* 0.1060 0.6120 0.8330 0.0031*					ST 150 W 145 NW 145 NW 135	i00 - 1 100 - 1	H		Ŷ			
LTMSLAB[ A]:LTMSAF LTMSLAB[ A]:LTMSAF				-0.89 -2.76	0.3782 0.0075*					130	00- 1	¥ I					
LTMSLAB[ G1]:LTMSAP				-2.76	0.0783					125	00 -						
IND[ 822-1]			159.3557	0.04	0.9701					120	00	1					
⊿ Effect Tests											2 3	7 13 14 A	4 15 2 3 2 2 B D G	3			
6			Sum of										LAB / LTMSAPP				
Source LTMSLAB	Nparm	DF 3 3	Squares 5196179	1.7588	Prob > F 0.1643												
LTMSAPP[LTMSLAB]	2		18874767	4.7915	0.1643												
IND			1397	0.0014	0.9701												



#### Exploring Soot4 & MRV Parameter for Stand Differences

- Plot suggests high Fuel Dilution (@Hour252) relationship with Soot4 and MRV Parameters for Test Key 98616-T11 (Aug 2014)
- ▲ If this point is removed, there is no significant difference between Stands within a Lab for Soot4 & MRV is marginally significant (p=0.068)

