4. Control Charts.

In Section 1, the construction of the control charts that constitute the Lubricant Test Monitoring System is outlined. The constants used for the construction of the control charts for the L-37, and the response necessary in the case of control chart limit alarms, are depicted below. Note that control charting all critical parameters is required.

LUBRICANT TEST MONITORING SYSTEM CONSTANTS

		EWMA Chart				Shewhart Chart	
		LAMBDA		K		K	
Chart Level	Limit Type	Precision	Severity	Precision	Severity	Precision	Severity
Stand	Warning	0.2	--	2.24	--	--	1.80
	Action	0.2	0.2	2.81	1.96	2.10	1.80
Lab	Action	0.2	0.2	2.81	3.03	--	1.80
Industry	Warning	0.2	0.2	2.24	2.49	--	--
	Action	0.2	0.2	2.88	3.03	--	--

The following are the steps that must be taken in the case of exceeding control chart limits.

- Exceed EWMA test stand chart action limit for severity
  - Calculate test stand Severity Adjustment (SA) for each parameter that exceeds action limit, using the current test stand EWMA (Z_i) as follows:

    Non-lubrited Test Hardware:
    Ridging: SA = ($-Z_i$) x (0.666)
    Rippling: SA = ($-Z_i$) x (0.557)
    Pitting/Spalling: SA = ($-Z_i$) x (0.847)
    Wear: SA = ($-Z_i$) x (0.713)

    Lubrited Test Hardware:
    Ridging: SA = ($-Z_i$) x (1.430)
    Rippling: SA = ($-Z_i$) x (0.476)
    Pitting/Spalling: SA = ($-Z_i$) x (0.579)
    Wear: SA = ($-Z_i$) x (0.519)

Confirm calculations with the TMC.

  - SA calculations are for information purposes only.

- Result outside acceptance band
  - Conduct an additional calibration test.

The following industry issues are handled by the TMC and do not require individual laboratory action.

- Exceed EWMA industry chart action limit
  - TMC to notify surveillance panel chairman. Meeting of the TMC and the surveillance panel required to determine course of action.
- Exceed EWMA industry chart warning limit
  - TMC to notify surveillance panel chairman. Coordination of TMC and surveillance panel required to discuss potential problem.

D5800 Volatility by Noack Test Reference Oil Targets					
		Effective Dates		Sample Evaporation Loss	
Oil	n	From[1]	To[2]	$\overline{X}$	s
51	NA	***	20000925	18.13	0.42
52	NA	***	20000925	13.39	0.40
	59	20000926	20030720	13.61	0.49
	33	20030721	***	13.75	0.61
53	NA	***	20000925	22.30	0.55
54	NA	***	20000925	23.54	0.67
55	NA	***	20000925	16.21	0.48
	60	20000926	20030720	16.39	0.66
	32	20030721	***	17.09	0.76
58	59	20000926	20030720	14.46	0.52
	37	20030721	***	15.20	0.72
VOLC12	24	20130918	***	14.19	0.73[3]
VOLD12	27	20130918	***	12.52	0.73[3]
VOLE12	27	20130918	***	16.74	0.73[3]

1 Effective for all tests completed on or after this date.
2 *** = currently in effect.
3 based on a pooled standard deviation of data from 2014-2016

Test Area	Effective		Condition	Description
	From	To		
T-12	***	***	All tests using UUXO Hardware	Multiply Average Top Ring Weight Loss by 0.849
				Multiply Average Cylinder Liner Wear by 0.566
				$\Delta Lead_{Final}$ = exp[(ln(ΔLead) x 0.797)]
				$\Delta Lead\ (250\text{-}300)_{Final}$ = exp[(ln(ΔLead 250-300) x 0.700)]
				OC = exp[(ln($OC_{100\text{-}300}$) x 0.916)]
	*	August 26, 2014	All tests using VUXO Hardware	Multiply Average Top Ring Weight Loss by 0.849
				Multiply Average Cylinder Liner Wear by 0.566
				$\Delta Lead_{Final}$ = exp[(ln(ΔLead) x 0.797)]
				$\Delta Lead\ (250\text{-}300)_{Final}$ = exp[(ln(ΔLead 250-300) x 0.700)]
				OC = exp[(ln($OC_{100\text{-}300}$) x 0.916)]
	August 26, 2014	***	All tests using VUXO Hardware	Multiply Average Top Ring Weight Loss by 0.719
				Multiply Average Cylinder Liner Wear by 0.818
				$\Delta Lead_{Final}$ = exp[(ln(ΔLead) x 0.813)]
				$\Delta Lead\ (250\text{-}300)_{Final}$ = exp[(ln(ΔLead 250-300) x 0.710)]
				OC = exp[(ln($OC_{100\text{-}300}$) x 0.913)]
	August 4, 2015	***	All test using VUXOA or VUXOB Hardware	Multiply Average Top Ring Weight Loss by 0.912
				Multiply Average Cylinder Liner Wear by 0.953
				$\Delta Lead\ (250\text{-}300)_{Final}$ = exp[(ln(ΔLead 250-300) x 0.895)]
				$\Delta Lead_{Final}$ = exp[(ln(ΔLead) x 0.954)]
				OC = exp[(ln($OC_{100\text{-}300}$) x 0.942)]
	February 25, 2016	***	All test using VUYPx	Multiply Average Top Ring Weight Loss by 0.912
				Multiply Average Cylinder Liner Wear by 0.970
				If $OC_{100\text{-}300} > 65.0$ $\Delta Lead(250\text{-}300)_{Final}$ = exp[(ln(ΔLead(250-300) + (65.0 - $OC_{100\text{-}300}$) x 0.04021)] If $OC_{100\text{-}300} \leq 65.0$ $\Delta Lead(250\text{-}300)_{Final}$ = ΔLead(250-300)
				If $OC_{100\text{-}300} > 65.0$ $\Delta Lead_{Final}$ = exp[(ln(ΔLead) + (65.0 - $OC_{100\text{-}300}$) x 0.03088] If $OC_{100\text{-}300} \leq 65.0$ $\Delta Lead_{Final}$ = ΔLead

History of Industry Correction Factors
Appendix B

Test Area	Effective		Condition	Correction
	From	To		
VIII	None		All Tests	None

Test Area	Effective		Condition	Description
	From	To		
1M-PC	None		All Tests	None
1K	None		All Tests	None
1N	May 1, 2004	September 27, 2005	All Tests	Add -1.135 to ln(TLHC+1)
	September 28, 2005	March 31,2015	All Tests	Add -0.451 to ln(TLHC+1)
	April 1,2015	***	All Tests on 1Y3998 Liners	Add 0.419954 to ln(TGF+1)
1P	None		All Tests	None
1R	None		All Tests	None
C13	None		All Tests	None
COAT	None		All Tests	None
ISB	April 21, 2011	***	All tests using batch B tappets with batch E, F, and G cams	Multiply ATWL by 0.637; Add -9.5 to ACSW
ISB	December 11, 2011	November 12, 2012	All tests using batch C tappets with batch H cams	Multiply ATWL by 0.637; Add -9.5 to ACSW
ISB	November 13, 2012	***	All tests using batch C tappets with batch H and J cams	Multiply ATWL by 0.711; Add -5.6 to ACSW
ISM	June 28, 2007	***	All Tests	Add +1.7 to Crosshead Wear At 3.9% Soot Add +19.1 to Injector Adjusting Screw Wear At 3.9% Soot
	March 4, 2010	***	All Tests	Add +1.3 to Crosshead Wear At 3.9% Soot
	April 30, 2011	***	All Tests	Add +2.5 to Crosshead Wear At 3.9% Soot
	November 19, 2013	***	All Tests	Add -0.200 to ln(SAIAS)
	October 1, 2014	***	All Tests	Add 4 kPa to Oil Filter Delta Pressure