



Team Results for Clean Snowmobile Challenge 2018 Team 3



2018 Clean Snowmobile Competition - Lab Emission Event Emission Data Sheet

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Test Date       : 2018/03/08 12:51:21
Team Name      : UM Duluth
Team Number    : 3
Model          : Polaris
Engine         : Pro Star
Displacement[cc] : 999.00
100% Speed     : 6535
100% Torque    : 71.0
No of Strokes  : 4
Fuel           : GASOLINE
                H/C: 2.04      O/C: 0.07
  
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ModeNum	:	1	2	3	4	5	RMC
Weighting	:	0.12	0.27	0.25	0.31	0.05	1.00
Power kW	:	49.2	21.1	12.0	6.0	0.0	15.8
HC_m g/hr	:	162.18	3.05	3.25	3.71	3.26	3.62
CO_m g/hr	:	4596.95	3.86	2.25	168.95	0.42	265.30
NOx_m g/hr	:	78.25	172.34	57.04	1.18	1.64	78.68
Soot_m mg/hr	:	110.34	0.49	0.18	0.28	0.05	5.02
N2O_m mg/hr	:	0.15	0.08	0.04	0.01	0.00	0.05
CO2_m g/hr	:	40172.91	22404.72	14527.91	9146.82	3739.13	18897.78
CH4_m g/hr	:	18.64	0.11	0.48	0.94	0.25	1.41
W_HC g/hr	:	19.46	0.82	0.81	1.15	0.16	3.62
W_CO g/hr	:	551.63	1.04	0.56	52.37	0.02	265.30
W_NOx g/hr	:	9.39	46.53	14.26	0.37	0.08	78.68
W_HCNOx g/hr	:	28.85	47.36	15.07	1.51	0.24	82.30
W_Soot mg/hr	:	13.24	0.13	0.05	0.09	0.00	5.02
W_N2O g/hr	:	0.02	0.02	0.01	0.00	0.00	0.05
W_CO2 g/hr	:	4820.75	6049.27	3631.98	2835.51	186.96	18897.78
W_CH4 g/hr	:	2.24	0.03	0.12	0.29	0.01	1.41

Total Weighted Power [kW] 16.470

Weighted Emissions

	HC	CO	NOx	HC+NOx
Total Mass [g/hr]	22.41	605.64	70.63	93.04
Specific Mass [g/kW-hr]	1.36	36.77	4.29	5.65
BSFC [g/kW-hr]	381.1			

Total Soot [mg/hr] 13.51 Specific Soot [mg/kW-hr] 0.82

Not Used for Competition

Total N2O [mg/hr]	0.05	Specific N2O [mg/kW-hr]	0.00
Total CO2 [g/hr]	17524.47	Specific CO2 [g/kW-hr]	1064.04
Total CH4 [g/hr]	2.69	Specific CH4 [g/kW-hr]	0.16
RMC BSFC [g/kW-hr]	390.06		

EMISSION TESTS:

	Value	Limit	Result
Power	48.60	<96.94 kW	PASS
Soot	0.82	<50 mg/kW-hr	PASS
CO	36.77	<275 g/kW-hr	PASS
HC + NOX	5.65	<90 g/kW-hr	PASS
E-Score	197.04	>175	PASS
Valid Data for All 5 Modes			PASS
RMC			PASS
LAB EMISSION TEST			PASS



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Modal Raw Data : Engine / Environmental

ModeNum		1	2	3	4	5	RMC
Total Points	points	600	1520	1200	1200	1200	11432
PtsInMode	points	1210	3370	3470	1800	1480	11432
Speed	rpm	6534.22	5554.40	4901.20	4250.19	1389.10	4958.99
Torque	Nm	71.92	36.29	23.39	13.51	0.00	30.50
Power	kW	49.21	21.11	12.01	6.01	0.00	15.84
BSFC	g/kw-hr	311.16	339.52	387.17	500.88	**	390.06
Fuel	g/hr	15311.71	7166.42	4648.08	3012.24	1198.64	6177.33
T_int	degC	22.48	26.06	22.77	22.19	25.02	24.09
RelHumid	%	30.19	26.98	22.61	29.60	25.64	27.32
Baro	in Hg	28.83	28.82	28.82	28.83	28.82	28.82
Baro	mmHg	732.21	732.07	732.08	732.17	732.07	732.12
Pvap_kPa	kPa	0.69	0.74	0.52	0.66	0.67	0.68
Pvap_inHg	inHg	0.20	0.22	0.15	0.20	0.20	0.20
AbsHumidity	grains/lb	30.83	33.36	23.42	29.74	29.99	30.42
SatPres	kPa	96.93	96.86	97.08	96.95	96.93	96.93
Hum Factor		0.83	0.84	0.80	0.82	0.83	0.83
F_fac		1.02	1.03	1.01	1.01	1.02	1.02
K_fac		1.03	1.03	1.03	1.03	1.03	1.03
Humidity	g/kg	4.40	4.77	3.35	4.25	4.28	4.35
H2		0.77	0.00	0.00	0.13	0.00	0.10
WetDry Factor		0.86	0.86	0.86	0.86	0.86	1.00



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Modal Emissions Concentrations

ModeNum		1	2	3	4	5	RMC
THC	ppmC1	1434.66	54.86	90.87	162.72	345.35	75.52
CO	%	2.04	0.00	0.00	0.37	0.00	0.28
N2O	ppm	4.14	4.66	3.53	1.00	0.35	3.29
CH4	ppm	144.98	1.74	11.75	36.40	23.25	25.82
CO2	%	11.36	12.87	12.97	12.83	12.68	12.62
O2	%	0.01	0.45	0.25	0.00	0.66	0.53
CNOx	ppm	211.67	947.33	487.03	15.83	53.15	502.55
AHC	ppm	14.59	1.72	1.33	1.41	0.63	3.05
C2H2	ppm	4.40	0.98	0.88	1.14	1.04	1.32
C2H4	ppm	47.44	0.66	1.07	1.48	7.47	6.11
C3H6	ppm	7.30	1.29	1.41	0.96	4.48	1.84
C4H6	ppm	6.65	0.86	0.76	2.80	1.51	1.79
ETOH	ppm	0.00	0.00	0.00	0.02	0.00	0.30
H2O	%	14.31	13.96	14.01	14.18	13.77	0.00
HCHO	ppm	1.23	1.11	1.21	1.32	4.58	1.14
HCN	ppm	20.26	0.19	0.17	0.32	0.08	2.61
HNCO	ppm	14.02	1.55	1.20	0.98	19.20	2.90
MECHO	ppm	0.00	0.61	3.30	0.00	2.01	1.12
NC5	ppm	4.96	3.05	2.93	3.71	8.10	3.51
NH3	ppm	138.86	0.25	0.08	53.49	0.85	24.15
NO	ppm	255.95	1132.57	605.42	19.69	64.12	607.96
NO2	ppm	0.10	0.38	0.20	0.03	0.33	0.21
Soot	mg/m3	0.59	0.01	0.00	0.01	0.00	0.06
AFR	:1	12.14	13.76	13.59	13.21	13.79	13.67



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Measurement Accuracy (SAE paper 961804)

ModeNum	H2_XLS %	ModalHC_Dry %	ModalFTIR_H2O %	N2 %	Ar %	AFR :1	Tr_Eff -
1	0.902	0.167	14.312	80.481	0.930	13.687	0.999
2	0.001	0.006	13.964	83.835	0.969	15.184	0.977
3	0.001	0.011	14.008	83.377	0.964	15.009	0.987
4	0.150	0.019	14.177	82.810	0.957	14.610	1.000
5	0.001	0.040	13.773	83.206	0.962	15.280	0.966

ModeNum	ModalWHC %	ModalC1 %	ModalC8 %	ModalSUM_HC %	ModalT_Emiss %	ModalError %
1	162.176	0.157	0.020	0.176	98.175	1.825
2	3.052	-0.335	-0.042	-0.377	100.050	0.050
3	3.254	-0.183	-0.023	-0.206	99.582	0.418
4	3.707	0.019	0.002	0.021	99.330	0.670
5	3.255	-0.457	-0.057	-0.514	99.141	0.859

Carbon Balance Verification

		1	2	3	4	5	6
Power	kW	49.209	21.107	12.005	6.014	0.000	15.837
BSFC	g/kw-hr	311.16	339.52	387.17	500.88	**	390.06
Fuel_MassFlow	g/hr	15312	7166	4648	3012	1199	6177
HC_m	g/hr	162.18	3.05	3.25	3.71	3.26	3.62
CO_m	g/hr	4597.0	3.9	2.3	168.9	0.4	265.3
CO2_m	g/hr	40173	22405	14528	9147	3739	18898
TW_Power	kW	16.470					
TW_BSFC	g/kw-hr	381.08					
Fuel_MassFlow	g/hr	15312	7166	4648	3012	1199	6177
FuelCalc	g/hr	16560	7737	5019	3253	1295	6670
FuelCalcDev	%	-8.1552	-7.9675	-7.9726	-7.9823	-8.0098	-7.9704

\$HCR_ENG	2.04
\$OCR_ENG	0.07
MassFracCFuel H/C ratio	0.79086

Power Run

Team 3

TeamNumber	3
TeamName	UM Duluth
Model	Polaris
Engine	Pro Star

Displacement cc	999.00
RatedSpeed	6535
RatedTorque	71.0

