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Full-Scale Engine Detonation Tests of 47 Unleaded, High-Octane Blends

David Atwood

September 2008

Final Report

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16. Abstract

As of this writing, the Environmental Protection Agency's (EPA) exemption of general aviation from the 1990 Clean Air Act Amendments regarding the use of leaded fuel is still in effect. Recent petitions to the EPA have reignited the call for either a ban on leaded aviation fuels or commission a study on the health effects of leaded aviation fuels. It is likely that environmental and cost pressures of using leaded fuels will continue to increase for the general aviation community. Extensive testing by the Federal Aviation Administration (FAA) William J. Hughes Techical Center on an unleaded replacement for the current leaded 100 low-lead (100LL) aviation gasoline involved the use of specialty chemicals. Significant engine modifications may also be required on the high-compression engine legacy fleet to operate on a lower-octane, unleaded fuel, which would likely result in changes to engine and aircraft performance and pilot-operating procedures. Recent FAA tests confirmed that significant detonation performance differences exist between unleaded and leaded fuels of the same octane. The need for the FAA Propulsion and Fuel Systems Team to continue research on unleaded fuels and to evaluate engine technology is greater than ever as safety and certification concerns increase with the use of alternative fuels.

Working in parallel with the Coordinating Research Council, the Propulsion and Fuel Systems Team was supplied with 47 separate blends of unleaded fuel containing various amounts of aviation alkylate, super alkylate, Toluene, Ethyl-tert-butyl-ether, tert-Butylbenzene, and meta-Toluidine. All blends contained 5% Isopentane. The blends' compositions had motor octane numbers (MON) ranging from 97.6 to 106.3, and did not meet the current American Society for Testing and Materials (ASTM) D 910 leaded aviation gasoline specification. These 47 blends, along with a specially blended, minimum specification 100LL and unleaded reference fuels, were detonation-tested in a Lycoming IO540-K engine at the FAA William J. Hughes Technical Center. The goal was to address both the individual and synergistic compositional effects of the unleaded components on the full-scale engine detonation performance and on the ASTM D 2700 laboratory MON. The MON was correlated to the full-scale engine detonation performance and compared to the detonation performance of the specially blended 100LL.

Four power settings, ranging from takeoff to economy cruise, were evaluated with fuel mixture strength varying from 0.600 brake-specific fuel consumption to 50°F lean of peak exhaust gas temperature. Results show that the MON of the blends did trend with their detonation performance in the IO540-K engine, but equivalent unleaded blend performance of the specially blended 100LL required 2.0 greater MON. Nineteen of the 47 blends, all with higher than 102.5 MON, provided better detonation performance than the specially blended 100LL. Fourteen of the blends had higher MONs than the 100LL but performed worse in the full-scale engine.

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LIST OF ACRONYMS AND ABBREVIATIONS

100LL	100 low-lead aviation gasoline
AN	Amine number
BHP	Brake horsepower
BSFC	Brake-specific fuel consumption
EGT	Exhaust gas temperature
ETBE	Ethyl-tert-butyl-ether
FAA	Federal Aviation Administration
FF	Fuel mass flow rate
GA	General aviation
gal.	gallon
ISO	Isooctane
MAP	Manifold absolute pressure
MON	Motor octane number
PN	Performance number
rpm	Revolutions per minute
TEL	Tetra-ethyl lead
TO	Takeoff
v/v	By volume

EXECUTIVE SUMMARY

Researchers at the Federal Aviation Administration (FAA) Small Engine Test Facility located at the FAA William J. Hughes Technical Center (Technical Center) have worked closely with aircraft manufacturers, engine manufacturers, petroleum producers, chemical companies, universities, regulatory agencies, aircraft owners, and users' associations providing full-scale engine test data on alternative fuels to facilitate the development of a safe, high-octane, unleaded aviation gasoline for spark-ignition, piston aircraft engines. The 1990 Federal Clean Air Act Amendments banned the sale of leaded fuels for on-road vehicles but exempted the sale of leaded fuels for off-road use, such as aircraft, racing cars, farm equipment, and marine engines. This resulted in the general aviation (GA) community becoming the largest domestic consumer of leaded fuels. With environmental pressures increasing worldwide against the use of leaded fuels and lead scavenging agents, the future status of the Environmental Protection Agency exemption for GA is uncertain and is increasingly a subject of debate.

Forty-seven unleaded blends were detonation-tested in a full-scale Lycoming IO540-K engine by the Propulsion and Fuel Systems Team Small Engine Test Facility at the FAA Technical Center. These 47 blends contained varying ranges of super alkylate, aviation alkylate, Toluene, Ethyl-tert-butyl-ether, tert-Butylbenzene, and meta-Toluidine. Each blend also contained 5% Isopentane. This testing is follow-up work to full-scale engine detonation tests of 30 unleaded blends that were tested at the FAA Technical Center Small Engine Test Facility.

The 47 blends ranged from 97.6 to 106.3 motor octane number (MON), as determined by the ASTM D 2700. None of these blends met the ASTM D 910 specification. The goal of this research was to correlate the full-scale engine detonation performance of 47 unleaded blends to their laboratory MONs and to their specific compositions.

The detonation performance of the 47 unleaded matrix blends were also compared to the detonation performance of a baseline ASTM D 910 100 low-lead aviation gasoline (100LL). The baseline 100LL was made from typical aviation gasoline components and had an ASTM D 2700 MON of 100.6, an ASTM D 909 supercharge performance number of 130.9, and contained 1.55 mL tetra-ethyl lead (TEL) per gallon (gal). The baseline 100LL was blended for minimum-allowable MON and performance number by ASTM D 910 with a high, but allowable, amount of lead.

The 47 blends detonation performance was also compared to the performance of a 100LL purchased from a local airport. The airport 100LL had an ASTM D 2700 MON of 103.9, an ASTM D 909 performance number of 131.5, and contained 1.88 mL TEL/gal.

The blends' detonation performance was analyzed using five detonation-onset parameters. The results showed that the detonation performance of the unleaded blends in the full-scale engine trend with the blend's MON. Based on detonation-onset fuel mass flow, 19 of the 47 blends performed better than the specially blended, minimum performance 100LL. All 19 blends had MONs greater than 102.8. Fourteen of the blends that had higher MONs than the baseline 100LL (some as high as 103) did not perform as well as the 100LL. When averaged over all

the detonation-onset parameters investigated, the unleaded blends required a minimum of 2.0 higher MON for equivalent detonation performance in the full-scale engine.

First-order, linear regressions on the blend composition showed that the meta-Toluidine concentration had a strong correlation to the blend's MON and full-scale engine detonation performance. Equivalent detonation performance to the minimum specification 100LL was found with the addition of between 6% and 9.5% by volume meta-Toluidine, respective of the detonation-onset comparator. None of the blends with less than 6% by volume meta-Toluidine performed as well as the minimum specification 100LL in the detonation tests. All the blends, except for two, with greater than 6% by volume meta-Toluidine, had MONs of 102.5 or higher.

Similar trends were shown for any of the other components. This may be due to the dominance of the meta-Toluidine. The compositional data will be further subjected to advanced statistical analyses in an effort to develop a full-scale engine knock performance model for these specific unleaded fuel components. This predictive model will incorporate both individual component and cross-product composition to the blend's full-scale engine detonation performance and laboratory MON.

1. INTRODUCTION.

1.1 PURPOSE.

This research addressed the relationship between the specific composition and the motor octane number (MON) of 47 unleaded blends, determined by the ASTM D 2700 standard, and their detonation performance in a high-output, spark-ignition, piston aircraft engine. Also, addressed was the full-scale engine detonation comparison to a minimum specification 100 low-lead aviation gasoline (100LL).

1.2 BACKGROUND.

The 1990 Federal Clean Air Act Amendments banned the sale of leaded fuels for on-road vehicles but exempted the sale of leaded fuels for off-road use, such as aircraft, racing cars, farm equipment, and marine engines. This resulted in the general aviation (GA) community becoming the largest domestic consumer of leaded fuels. With environmental pressures increasing worldwide against the use of leaded fuels and lead scavenging agents, the future status of the Environmental Protection Agency exemption for GA is uncertain and is increasingly a subject of debate.

For more than a decade the Federal Aviation Administration (FAA) Propulsion and Fuel Systems Team at the FAA William J. Hughes Technical Center (Technical Center) has been a leading engine test facility providing full-scale engine test research on unleaded fuels for the petroleum industry, airframe and engine manufacturers, regulatory agencies, aircraft users and owners associations, universities, and chemical companies to facilitate the development of an unleaded, high-octane alternative to the current 100LL.

Traditionally, most GA spark-ignition reciprocating engines and airframes have been certified on leaded fuels that meet the ASTM D 910 aviation gasoline specification. For obvious safety reasons, any alternative unleaded fuel would have to meet the octane requirements of the majority of the aviation fleet that was certified on high-octane leaded fuels. A century of test data made it clear that the detonation performance of leaded fuels can vary significantly from the performance of unleaded fuels with the same ASTM D 2700 MON in a full-scale engine.

The FAA Technical Center Small-Engine Test Facility was instrumental in the recent and significant progress in the area of full-scale engine performance of unleaded fuels. Recently, the FAA Technical Center published research on the full-scale engine detonation performance of 30 unleaded blends in FAA report DOT/FAA/AR-04/25, “Full-Scale Engine Knock Tests of 30 Unleaded, High-Octane Blends.”

The present research is a continuation of the above research. From the results of the 30 blends, another matrix of 47 unleaded blends was developed and detonation-tested in a Lycoming IO540-K engine at the FAA Technical Center Small-Engine Test Facility. These blends contained various ranges of high-octane components, such as aviation alkylate, super alkylate, Toluene, Ethyl-tert-butyl-ether (ETBE), tert-Butylbenzene, meta-Toluidine (3-methylphenylamine), and Isopentane.

The objective of this research was to determine if the ASTM D 2700 MON of the unleaded blends adequately addressed their actual detonation performance in a full-scale piston aircraft engine and to determine the first- and second-order effects of composition on both the ASTM D 2700 MON and the full-scale engine detonation performance. A baseline leaded reference fuel, specially blended to meet all the specifications of the current ASTM D 910 for 100LL with the minimum MON and minimum performance number (PN), per ASTM D 909, and containing near the maximum amount of allowable lead, was tested. Also tested was a 100LL purchased from a local airport. The knock performances of the 47 unleaded blends were compared against one another, against the performance of the baseline 100LL, and against the performance of the airport 100LL.

1.3 RELATED DOCUMENTS.

- ASTM D 909, "Standard Test Method for Knock Characteristics of Motor and Aviation Fuels by the Supercharge Method."
- ASTM D 910, "Standard Specification for Aviation Gasoline."
- ASTM D 2700, "Standard Test Method for Knock Characteristics of Motor and Aviation Fuels by the Motor Method."
- ASTM D 6424, "Standard Practice for Octane Rating Naturally Aspirated Spark Ignition Aircraft Engines."
- FAA Advisory Circular 20-24B, "Qualification of Fuels, Lubricants, and Additives for Aircraft Engines."
- FAA Advisory Circular 33-47, "Detonation Testing in Reciprocating Aircraft Engines."
- FAA Report DOT/FAA/AR-04/25, "Full-Scale Engine Detonation Tests of 30 Unleaded, High-Octane Blends," D. Atwood and J. Canizales.
- FAA Report DOT/FAA/AR-99/70, "Evaluation of Reciprocating Aircraft Engines With Unleaded Fuels," D. Atwood.
- "Unleaded Aviation Gasoline Development Program—Phase III Composition and MON Ratings of Experimental Fuels for Full-Scale Engine Tests at FAA Technical Center," Dixie Services Incorporated, M. Renz, 1997.

2. TEST PROCEDURES.

2.1 FUEL BLENDS.

Dixie Services Incorporated shipped 47 blends, ranging in MONs from 97.6 to 106.3, in 40-gallon batches to the Propulsion and Fuel Systems Team at the FAA Technical Center.

The constraints for the 47 unleaded fuel blend component matrix are shown in table 1.

Table 1. Unleaded Blend Component Constraints

Blend Components	Constraint (volume %)
aviation alkylate	0-60
super alkylate	0-50
Toluene	0-20
tert-Butylbenzene	0-20
meta-Toluidine	3-12
Ethyl-tert-butyl-ether (ETBE)	0-30
Isopentane, constant for all blends	5
Total aromatic content	30 maximum
Total alkylate (Aviation+Super+Isopentane)	75 maximum
Total aviation alkylate + Isopentane	65 maximum

The exact formulation of each test blend is shown in tables 2 through 5. The physical property data for the 47 blends, per the specifications in ASTM D 910, is listed in tables 6 and 7. The properties of the blend components are shown in appendix A.

Tables 2 and 3 contain the volume fractional component data, and tables 4 and 5 contain the mass fractional component data.

Table 2. Actual Component Volume Fractions of Blends 1 to 25

Blend Number	Aviation Alkylate	Super Alkylate	Toluene	tert-Butylbenzene	meta-Toluidine	ETBE	Isopentane
1	0.4224	0.0000	0.0000	0.1995	0.0308	0.2973	0.0501
2	0.2689	0.2702	0.1016	0.1912	0.1180	0.0000	0.0501
3	0.0000	0.2299	0.1640	0.1359	0.1205	0.2997	0.0500
4	0.5998	0.0171	0.0130	0.1998	0.1201	0.0000	0.0501
5	0.0000	0.4998	0.0841	0.1569	0.0832	0.1260	0.0501
6	0.1298	0.5001	0.0000	0.1998	0.1201	0.0000	0.0502
7	0.1672	0.4997	0.0107	0.1002	0.0657	0.1063	0.0501
8	0.4162	0.2837	0.0000	0.0360	0.1201	0.0939	0.0501
9	0.0000	0.3969	0.1689	0.0000	0.0838	0.3002	0.0501
10	0.2487	0.2350	0.0588	0.0000	0.1073	0.3001	0.0501
11	0.1720	0.2198	0.1979	0.0298	0.0302	0.3002	0.0501
12	0.0010	0.4999	0.1071	0.0742	0.0309	0.2369	0.0501
13	0.6000	0.0438	0.0107	0.1041	0.0651	0.1261	0.0502
14	0.3291	0.0000	0.2000	0.0000	0.1199	0.2998	0.0511
15	0.1029	0.5001	0.0910	0.0069	0.1202	0.1288	0.0502
16	0.2949	0.3949	0.1482	0.0321	0.0798	0.0000	0.0501
17	0.0903	0.4997	0.0000	0.0000	0.0597	0.3002	0.0501
18	0.5468	0.0000	0.1001	0.1997	0.0389	0.0643	0.0501
19	0.5998	0.0000	0.0321	0.0000	0.0302	0.2878	0.0501
20	0.3929	0.0000	0.0000	0.1369	0.1200	0.3001	0.0501
21	0.0000	0.4290	0.0000	0.1009	0.1200	0.3000	0.0501
22	0.1009	0.4997	0.2003	0.0000	0.0302	0.1188	0.0501
23	0.5997	0.0000	0.0000	0.0000	0.1080	0.2422	0.0501
24	0.1893	0.2294	0.0206	0.1997	0.0892	0.2216	0.0501
25	0.1671	0.4995	0.0802	0.1728	0.0302	0.0000	0.0501

Table 3. Actual Component Volume Fractions of Blends 26 to 47

Blend Number	Aviation Alkylate	Super Alkylate	Toluene	tert-Butylbenzene	meta-Toluidine	ETBE	Isopentane
26	0.4509	0.0152	0.1178	0.0911	0.1201	0.1547	0.0501
27	0.2949	0.3949	0.1482	0.0321	0.0798	0.0000	0.0501
28	0.1298	0.5001	0.0000	0.1998	0.1201	0.0000	0.0502
29	0.4392	0.2609	0.0031	0.1967	0.0349	0.0152	0.0501
30	0.5960	0.1038	0.1369	0.0811	0.0302	0.0018	0.0501
31	0.0298	0.4996	0.2002	0.1002	0.1200	0.0000	0.0501
32	0.3797	0.3199	0.0673	0.0000	0.0302	0.1528	0.0501
33	0.5299	0.0219	0.1901	0.0000	0.0590	0.1491	0.0501
34	0.3489	0.0000	0.1950	0.1049	0.0302	0.2709	0.0501
35	0.5997	0.1000	0.1239	0.0000	0.1201	0.0063	0.0501
36	0.2949	0.3949	0.1482	0.0321	0.0798	0.0000	0.0501
37	0.5998	0.0171	0.0130	0.1998	0.1201	0.0000	0.0501
38	0.0000	0.3198	0.1001	0.1997	0.0302	0.3002	0.0501
39	0.2439	0.2588	0.0160	0.1009	0.0302	0.3001	0.0501
40	0.0000	0.5000	0.0000	0.1998	0.0302	0.2199	0.0501
41	0.1901	0.2853	0.2001	0.0321	0.1200	0.1223	0.0501
42	0.4026	0.0000	0.0978	0.0780	0.0711	0.3003	0.0501
43	0.5539	0.0000	0.2001	0.1001	0.0958	0.0000	0.0501
44	0.2701	0.0000	0.1002	0.1998	0.0919	0.2879	0.0501
45	0.2141	0.2987	0.1910	0.1086	0.0483	0.0893	0.0501
46	0.0000	0.8102	0.0000	0.1002	0.0000	0.0000	0.0896
47	0.0000	0.4796	0.0000	0.1499	0.0000	0.3002	0.0704

Table 4. Actual Component Mass Fractions of Blends 1 to 25

Blend Number	Aviation Alkylate	Super Alkylate	Toluene	tert-Butylbenzene	meta-Toluidine	ETBE	Isopentane
1	0.3904	0.0000	0.0000	0.2316	0.0408	0.2955	0.0417
2	0.2393	0.2427	0.1137	0.2137	0.1504	0.0000	0.0402
3	0.0000	0.2020	0.1795	0.1486	0.1503	0.2805	0.0392
4	0.5445	0.0157	0.0148	0.2277	0.1562	0.0000	0.0410
5	0.0000	0.4557	0.0955	0.1780	0.1076	0.1224	0.0408
6	0.1177	0.4577	0.0000	0.2276	0.1561	0.0000	0.0410
7	0.1570	0.4738	0.0126	0.1182	0.0884	0.1074	0.0424
8	0.3904	0.2687	0.0000	0.0424	0.1614	0.0947	0.0424
9	0.0000	0.3639	0.1928	0.0000	0.1091	0.2932	0.0410
10	0.2300	0.2194	0.0684	0.0000	0.1421	0.2984	0.0417
11	0.1576	0.2033	0.2280	0.0343	0.0396	0.2958	0.0414
12	0.0009	0.4683	0.1249	0.0865	0.0410	0.2364	0.0419
13	0.5647	0.0416	0.0127	0.1231	0.0878	0.1276	0.0425
14	0.2937	0.0000	0.2243	0.0000	0.1533	0.2877	0.0411
15	0.0947	0.4646	0.1053	0.0080	0.1584	0.1274	0.0416
16	0.2731	0.3692	0.1726	0.0374	0.1059	0.0000	0.0418
17	0.0862	0.4812	0.0000	0.0000	0.0816	0.3080	0.0431
18	0.5000	0.0000	0.1151	0.2293	0.0510	0.0633	0.0413
19	0.5778	0.0000	0.0389	0.0000	0.0417	0.2981	0.0435
20	0.3557	0.0000	0.0000	0.1557	0.1557	0.2922	0.0409
21	0.0000	0.3939	0.0000	0.1153	0.1563	0.2934	0.0410
22	0.0940	0.4700	0.2346	0.0000	0.0403	0.1191	0.0421
23	0.5657	0.0000	0.0000	0.0000	0.1460	0.2457	0.0426
24	0.1707	0.2088	0.0234	0.2262	0.1153	0.2149	0.0407
25	0.1551	0.4679	0.0936	0.2014	0.0401	0.0000	0.0419

Table 5. Actual Component Mass Fractions of Blends 26 to 47

Blend Number	Aviation Alkylate	Super Alkylate	Toluene	tert-Butylbenzene	meta-Toluidine	ETBE	Isopentane
26	0.4054	0.0138	0.1331	0.1029	0.1547	0.1495	0.0406
27	0.2731	0.3692	0.1726	0.0374	0.1059	0.0000	0.0418
28	0.1177	0.4577	0.0000	0.2276	0.1561	0.0000	0.0410
29	0.4125	0.2473	0.0036	0.2319	0.0469	0.0153	0.0424
30	0.5596	0.0984	0.1616	0.0957	0.0406	0.0018	0.0424
31	0.0264	0.4468	0.2230	0.1115	0.1523	0.0000	0.0400
32	0.3651	0.3105	0.0813	0.0000	0.0416	0.1580	0.0434
33	0.4902	0.0204	0.2211	0.0000	0.0782	0.1483	0.0417
34	0.3157	0.0000	0.2217	0.1191	0.0391	0.2635	0.0409
35	0.5552	0.0934	0.1441	0.0000	0.1593	0.0062	0.0418
36	0.2731	0.3692	0.1726	0.0374	0.1059	0.0000	0.0418
37	0.5445	0.0157	0.0148	0.2277	0.1562	0.0000	0.0410
38	0.0000	0.2907	0.1133	0.2258	0.0389	0.2907	0.0407
39	0.2294	0.2457	0.0190	0.1192	0.0407	0.3035	0.0425
40	0.0000	0.4671	0.0000	0.2322	0.0400	0.2189	0.0418
41	0.1700	0.2575	0.2249	0.0361	0.1536	0.1176	0.0403
42	0.3682	0.0000	0.1125	0.0896	0.0931	0.2953	0.0413
43	0.4974	0.0000	0.2259	0.1129	0.1233	0.0000	0.0405
44	0.2383	0.0000	0.1111	0.2214	0.1162	0.2731	0.0399
45	0.1943	0.2735	0.2178	0.1237	0.0627	0.0871	0.0409
46	0.0000	0.7983	0.0000	0.1229	0.0000	0.0000	0.0788
47	0.0000	0.4574	0.0000	0.1779	0.0000	0.3049	0.0599

Table 6. Property Data of Blends 1 Through 24

Blend	MON (ASTM D 2700)	Density (g/mL at 15°C)	Vapor Pressure (psi)
1	99.7	0.7501	
2	104.8	0.7792	
3	105.3	0.7996	3.17
4	103.9	0.7640	
5	104.1	0.7687	2.88
6	106.0	0.7648	
7	103.4	0.7388	
8	105.0	0.7400	
9	102.5	0.7625	
10	103.9	0.7511	
11	99.8	0.7572	
12	101.1	0.7473	5.24
13	101.2	0.7376	
14	104.0	0.7799	
15	106.3	0.7551	
16	102.8	0.7480	
17	102.7	0.7281	
18	99.6	0.7588	5.77
19	97.6	0.7197	
20	104.2	0.7688	
21	106.2	0.7654	
22	100.5	0.7445	5.64
23	103.0	0.7373	
24	103.3	0.7706	

Table 7. Property Data of Blends 25 Through 47

Blend	MON (ASTM D 2700)	Density (g/mL at 15°C)	Vapor Pressure (psi)
25	101.0	0.7476	
26	104.0	0.7732	
27	102.7	0.7484	
28	106.0	0.7654	
29	100.2	0.7387	
30	97.6	0.7391	
31	105.6	0.7824	
32	98.8	0.7208	
33	101.1	0.7497	
34	98.8	0.7677	
35	103.8	0.7491	
36	103.0	0.7482	
37	104.1	0.7642	
38	100.6	0.7719	
39	100.4	0.7374	
40	102.0	0.7500	3.22
41	104.8	0.7771	
42	101.5	0.7604	
43	102.6	0.7722	
44	102.9	0.7896	
45	101.1	0.7653	
46	98.2	0.7115	
47	99.8	0.7347	

Table 8 lists some of the properties of the 100LL fuels tested.

Table 8. Properties of the 100LLs Tested

ASTM Test	Test Description	100LL From Airport	Min Spec 100LL
D 2700	MON	103.6	100.6
D 5059	Lead content	0.48 mL TEL/L	0.41 mL TEL/L
D 5059	Lead content		1.64 Pb g/gal
D 1319	Aromatics	0.3 volume %	
D 4529	Net heat of combustion, 25°C	44.38 MJ/kg	
D 909	Supercharge rating	1.51 mL TEL/gal	1.35 mL TEL/gal
D 909	Performance number	133.0	130.9

Min Spec = minimum specification
MJ = Mega Joules
Pb = Lead
TEL = Tetra-ethyl lead

2.2 TEST ENGINE.

A Lycoming IO540 K engine, which was previously used to evaluate 30 unleaded fuel blends and octane-rated as one of the four worst-case engines, was used as the test engine. This engine was originally broken in using Phillips Type M nondispersant, 20W-50 mineral oil and operated only on unleaded fuels, except for the brief testing of three 100LLs.

An eddy-current dynamometer was used for power absorption, and only the components required to operate the engine were installed. All engine tests and operation after the break-in period used AeroShell Oil W 15W-50 ashless dispersant aviation oil.

Table 9 lists the rated power and compression ratio of the Lycoming IO540 K engine. The IO in the engine model description refers to fuel injection and opposed cylinder, and the numerical value of the model description refers to the cubic-inch cylinder displacement.

Table 9. Lycoming IO540-K Engine Model Specifications

Engine Make and Model	Compression Ratio	Normal-Rated Power (BHP)	rpm	Cylinders	Bore (in.)	Stroke (in.)
Lycoming IO540-K	8.7	300	2700	6	5.125	4.375

BHP = Brake horsepower
rpm = Revolutions per minute

As part of the earlier tests, the cylinder assemblies were removed, drilled, and tapped in the fin area for the installation of a high-temperature, water-cooled piezoelectric pressure transducer. One transducer was installed in each cylinder head with the transducer face flush with the cylinder cavity. The transducers were connected to charge-to-voltage amplifiers, and the amplifiers were connected to a data acquisition system. Analog pressure signals were digitized at the rate of 50 kHz per cylinder. The pressure data was fed to a numerical knock quantification analyses routine, as detailed in ASTM D 6424.

The engine was also instrumented as listed in table 10, and engine parameter data were recorded for all channels at a rate of at least one scan every 1 second. Sensors used to measure these parameters were installed at the manufacturer's recommended locations whenever possible and were calibrated prior to any engine test. After the instrumentation was calibrated, a series of maintenance runs were performed to verify engine systems integrity and instrumentation accuracy. Prior to engine operation, the mixture cutoff and full-rich settings and the throttle stop and throw positions were verified.

Table 10. Sensors and Installation Locations

Parameter	Sensor Type	Sensor Location
Cylinder head temperatures 1-6	Bayonnet, J-type thermocouple	Manufacturer's specified location
Exhaust gas temperatures 1-6	Band clamp, K-type thermocouple	Exhaust pipe within 2 inches of exhaust flange
Intake air temperature	T-type thermocouple	Intake duct, just prior to throttle throat
Intake air pressure	Absolute pressure transducer	Intake duct, just prior to throttle throat
Mass airflow rate	Kurz™ mass flow meter	Straight, smooth section of intake air duct, 6 diameters downstream
Air-to-fuel ratio	Lambda exhaust sensors	Per sensor manufacturer's specification
Manifold absolute pressure	Absolute pressure transducer	Intake manifold plenum after the fuel-metering unit
Engine speed (rpm)	Magnetic pickup	Dynamometer shaft
Engine shaft torque	Load cell	Dynamometer
Brake horsepower	Calculation	N/A
Fuel mass flow rate	Coriolis mass flow meter	Before fuel-metering unit and fuel manifold
Engine cowling air temperature	T-type thermocouple	Engine cowling plenum
Engine cowling air pressure	Gauge pressure transducer	Engine cowling plenum
Fuel temperature	Coriolis mass flow meter, Thermocouple	Before and after fuel-metering unit and prior to fuel manifold
Fuel mass density	Coriolis mass flow meter	After fuel-metering unit and prior to fuel manifold
Metered fuel pressure	Gauge pressure transducer	Output of fuel-metering unit
Fuel pump pressure	Gauge pressure transducer	Output of engine-driven fuel pump
Oil temperature	J-type thermocouple	Return from oil cooler
Oil pressure	Gauge pressure transducer	Manufacturer's location in accessory case

The fuel delivery system connects multiple fuel sources with one source containing the house fuel and the other sources containing the test blends. The integrity of the fuel system was checked prior to each run to ensure that cross-contamination did not occur.

The blends were tested at power settings covering takeoff (TO), 85%, 75%, and 65% power, as shown in table 11. TO is the condition of wide open throttle and maximum-rated revolutions per minute (rpm). The horsepower and rpm combinations were taken from the engine manufacturer's specifications. Tests were performed with the dynamometer controller operating in the speed mode so that the engine load was varied to maintain the desired rpm.

Table 11. Power Settings for Detonation Tests

Power	Manifold Absolute Pressure (inHg)	Engine Speed (rpm)
TO - normal-rated power	Wide open throttle	2700
85% of TO	Adjusted to attain power	2600
75% of TO	Adjusted to attain power	2450
65% of TO	Adjusted to attain power	2350

inHg = Inches of mercury

The tests followed the same procedures for adjusting the manifold absolute pressure (MAP), part throttle power, and mixture. Typically, the full-rich fuel mass flow rate (FF), obtained from the engine manufacturer's specifications for 100LL, was adjusted at TO. The resulting power was used to calculate the 85%, 75%, and 65% power. When adjusting the part throttle power settings, the engine rpm was set, the mixture setting was adjusted to attain a 0.600 brake-specific fuel consumption (BSFC) in lb/hp hr, and the MAP was adjusted until the desired power was attained. The resulting MAP was recorded, and any mixture leaning or enriching from this condition at the same rpm was performed while maintaining constant MAP. Mixture adjustments were performed automatically at a rate of change less than 1 lb/hr/s. All analyses and figures presented in this report were determined using FFs and not volume flow rates. Comparing the blends at constant fuel volume flow rates while the fuel temperature and the fuel mass density varied would result in unwanted fuel mixture variations. As mass is an intrinsic property, comparing the blends at constant FFs resulted in steady energy flow rates, irrespective of the fuel temperature or density.

Prior to testing the blends, the engine was octane-rated with unleaded reference fuels using procedures outlined in ASTM D 6424. The unleaded reference fuels were blends of ASTM reference-grade isooctane (ISO) and reagent-grade meta-Toluidine. MON was not used to describe the octane quality of these fuels but rather, the amine number (AN) was used. The AN of the reference fuel was equal to the weight percent of meta-Toluidine in ISO. For example, 105 AN refers to reference-grade ISO containing 5 weight percent reagent-grade meta-Toluidine (3-methylphenylamine). After the completion of the 47 blends tests and before testing the leaded fuels, the engine was again octane-rated using unleaded reference fuels.

Also, after completing the tests with the 47 blends and the unleaded reference fuels, the minimum specification and airport 100LLs were tested.

The engine tests began with warming the engine, ensuring that all instrumentation indications were within the proper range, and performing an ignition systems check. At this time, the engine and environmental parameters, shown in table 12, were set and maintained throughout the detonation tests. After selecting or changing a test blend or changing the engine power setting, conditions were allowed to stabilize. Enough time was given for the selected blend to reach the engine and for cylinder head temperatures to stabilize.

Table 12. Parameter Settings for Detonation Tests

Parameter	Limit
Maximum cylinder head temperature	475° +5°F (maximum per engine manufacturer's specifications)
All other cylinder head temperatures	Within 50°F of maximum cylinder head temperature
Induction air temperature	103° ±3°F
Induction air relative humidity	Less than 5%
Oil inlet temperature	245° -10°F (maximum per engine manufacturer's specifications)

The fuel mixture was leaned from a richer, nonknocking setting, until moderate to heavy detonation, maximum allowable exhaust gas temperature (EGT), or 50ºF past peak EGT has been reached. Careful attention was paid to the individual EGT and cylinder head temperature spreads and two exhaust Lambda sensors were used, one for each bank of cylinders. It was ensured that the cylinder head and EGT spreads and air-to-fuel reading differentials were minimal to prevent gross mixture imbalances between cylinders and cylinder banks.

Scheduled engine maintenance was performed every 50 engine hours.

The spark plugs were removed, and a cylinder borescope was employed to ensure that rings, valves, valve surfaces, and the piston crown were in visibly healthy condition. A run-up was performed, and a compression check was completed with the engine warm. The compression test used a differential pressure tester with a master orifice device, and the procedures followed those outlined in Textron Lycoming Service Instruction Number 1191A. The pressure across the orifice device was measured and recorded while 80 psi of air pressure was applied to the engine cylinders at the same time the respective piston was at top dead center of the compression stroke.

The fuel inlet screen (finger screen) was removed, cleaned, reinstalled, and safety wired. The system was then pressure-checked for evidence of leaks at the sealing gasket.

The engine cylinder assembly was inspected for evidence of overheating, leakage between exhaust ports and pipes, and warped exhaust port flanges. The baffling was inspected for condition and security.

The oil system was drained and the spin-on oil filter was changed. The oil pump scavenge screen was also removed and inspected for metal particles and contamination. The screen was then thoroughly cleaned, reinstalled, and safety wired. New gaskets were installed. The system was serviced to the proper level with AeroShell Oil 15W-50 multiviscosity aviation oil. The unleaded avgas program used AeroShell 15W-50 multiviscosity aviation oil during the tests and any oil usage during engine servicing was recorded.

All fluid-carrying lines were inspected for possible leaks or chafing. Electrical wiring was inspected for proper connections, security, and evidence of chafing as well.

Upon completion of the inspection, the engine cowling was reinstalled and a performance engine run-up test was completed. At this time, the engine was inspected for evidence of oil leaks and proper operation.

3. RESULTS AND DISCUSSION.

The engine health was monitored throughout the tests by means of static compression testing, power development, and cylinder borescope. Unleaded ASTM reference fuels were tested in the engine, both before and after the matrix fuels were evaluated. These unleaded reference fuels are blends of ASTM reference-grade ISO (2,2,4 tri-methylpentane) and reagent-grade meta-Toluidine (3-methylphenylamine) with the weight percent of meta-Toluidine in the blend determining the AN of the blend. Thus, a 103 AN blend was a blend of ISO containing 3 weight percent meta-Toluidine. The attempt was to determine if there was an octane requirement shift in the engine during the test. Samples of the unleaded reference blends were sent to a laboratory to determine the meta-Toluidine content for AN verification. Unfortunately, the sample bottles used were the wrong material and very little amine was found. No comparison could be made between the pretest AN blend results to the posttest AN blend results.

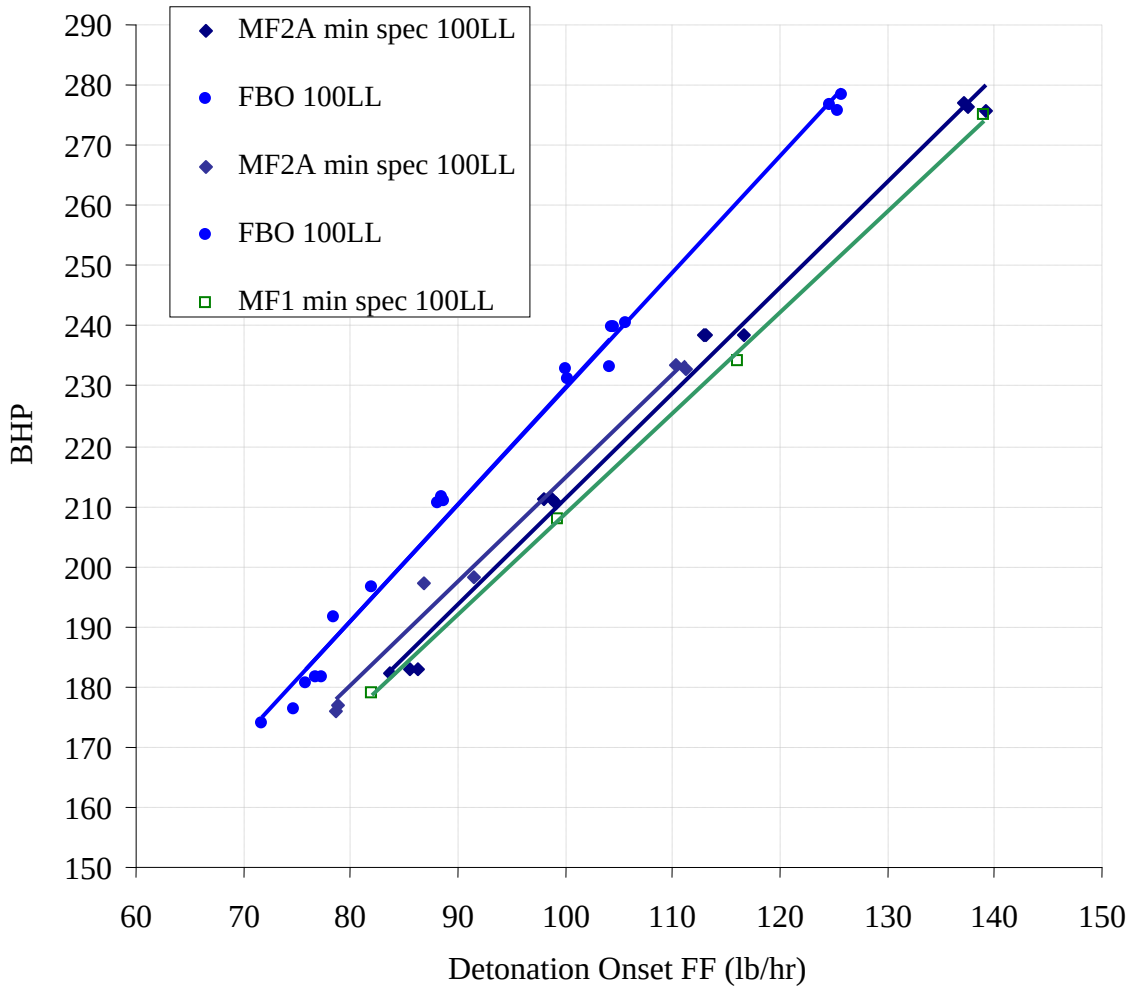
Static compression tests taken, both with the engine warm and cold, showed readings in the upper 60s and lower 70s throughout the test. Six readings were taken and these values did not change appreciably from before to after the test. Exhaust- and intake-valve recession measurements taken during this test also indicated that there was little wear occurring during the test.

Three separate leaded fuels were tested and are shown in table 13. The minimum specification 100LL labeled MF1 was tested previously, after the testing of the first 30 unleaded matrix fuel blends, as reported in DOT/FAA/AR-04/25, “Full-Scale Engine Knock Tests of 30 Unleaded, High-Octane Blends.” The MF2 100LL minimum specification fuel had roughly the same MON and PN as the MF1 100LL, with lower lead content and higher aromatic content. Figure 1 shows the detonation-onset performance of the 100LL blends. As the figure shows, the MF2 blend performed slightly better than the MF1 blend. This data suggests that there was no appreciable engine octane requirement shift during the test. Note that the leaded fuels were tested several times, and at different power settings, and the test results showed a high repeatability of less than 2 lb/hr. Also note that the 100LL purchased from the local airport had a 2.5 higher MON and a higher lead content than the minimum specification 100LL MF2, and it performed significantly better than the minimum specification 100LL in the engine.

Table 13. Leaded Aviation Gasolines Tested

	MON (ASTM D 2700)	PN (ASTM D 909)	Lead Content
MF1 Min Spec 100LL	100.3	131.5	2.03 mL TEL/gal
MF2 Min Spec 100LL	100.6	130.9	1.55 mL TEL/gal
FBO 100LL	103.6	133.0	1.70 mL TEL/gal

Min Spec = minimum specification
FBO = Fixed base operator
TEL = Tetra-ethyl lead



FBO = Fixed base operator
min spec = minimum specification

Figure 1. Detonation Performance of Minimum Specification 100LL and Local Fixed Base Operator 100LL

3.1 BLEND DETONATION PEFORMANCE COMPARISON.

Figure 2 shows a typical mixture leaning detonation response. As described in section 2, the engine is set at a BSFC of 0.600 lb/hp hr with the fuel mixture rich of best power for a given power setting. The mixture was leaned from this setting until either moderate to heavy detonation developed, 50ºF lean of peak EGT was achieved, or a maximum EGT of 1650ºF was reached. Detonation onset was considered to be the mixture setting of repeatable light detonation. The averaged mixture lean-out graphs for the 47 blends is shown in appendix B along with the detonation-onset values.

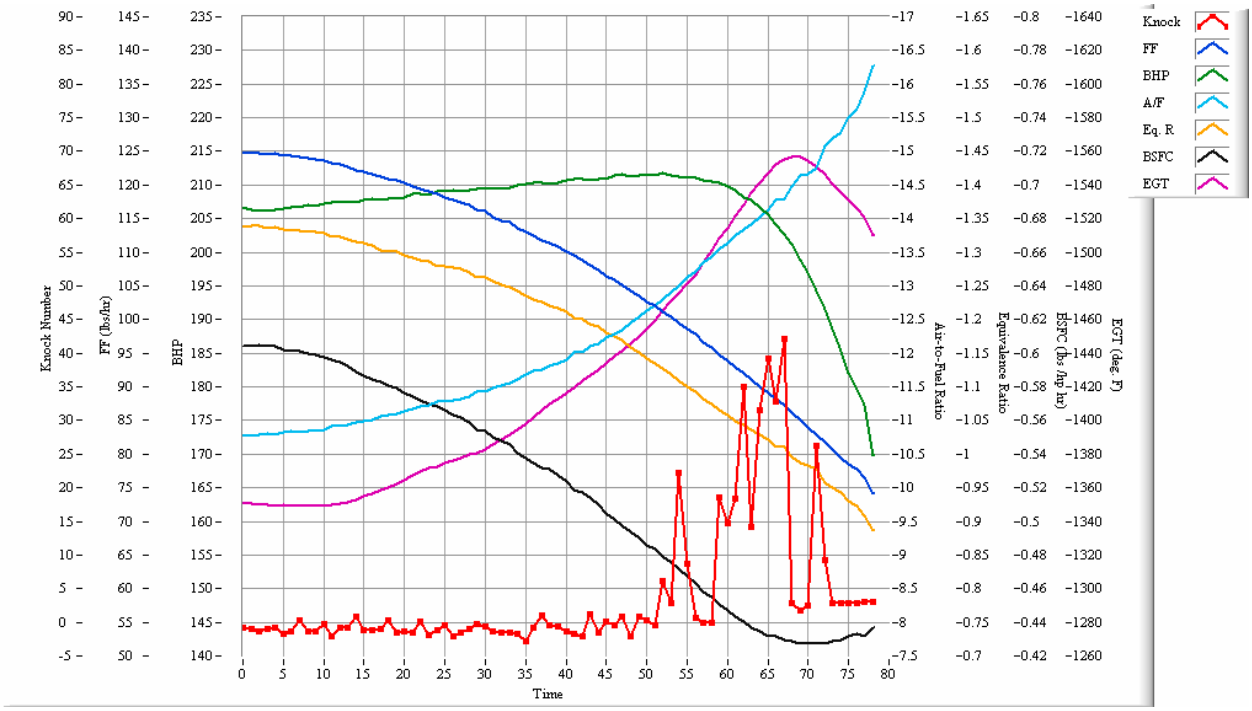


Figure 2. Detonation Response to Mixture Leaning

The equivalence ratio is a calculation based on the ratio of the stoichiometric air-to-fuel ratio to the actual air-to-fuel ratio. The stoichiometric air-to-fuel ratio refers to the mixture strength where there is neither excess fuel nor excess air remaining after combustion. Therefore, an equivalence ratio greater than 1.00 refers to a mixture setting that was rich of stoichiometry, equal to 1.00 is stoichiometry, and less than 1.00 refers to a mixture that was leaner than stoichiometry. The calculated stoichiometric air-to-fuel ratios for all 47 blends are shown in appendix C.

Using the detonation-onset equivalence ratio is a better measure for detonation performance of unleaded fuels than using the detonation-onset air-to-fuel ratio due to the effect of chemical composition of these blends. Use of the equivalence ratio is also a more advanced method than the traditional use of the average EGT. However, lower air-to-fuel stoichiometric ratios requires increased fuel mass flow consumption for engine operation.

The BSFC takes both the fuel flow rate and the horsepower output into account. The BSFC is calculated by dividing the FF in lb/hr by the brake horsepower (BHP) output. Thus, the higher the FF for a given horsepower output, the higher the BSFC. For two blends that developed detonation-onset conditions at the same FF, the blend with the higher horsepower at this flow rate would be considered the better performer.

Figure 2 shows that as the mixture is leaned from the setting rich of best power (i.e., moving from left to right on the graph), the BHP, average EGT, and air-to-fuel ratio will increase, and the FF, equivalence ratio, and BSFC will decrease. The BHP will continue to increase with leaner mixtures until peak power mixture is attained. Continued leaning of the mixture results in the BHP, equivalence ratio, and BSFC decreasing as the average EGT and air-to-fuel ratio increases. When the mixture setting has leaned to the point where the equivalence ratio reaches a value near 1.00, the EGT will reach its maximum value. Slightly lean of the peak EGT setting minimum BSFC, or best efficiency, is attained. Continued leaning typically results in the BSFC increasing while the EGT decreases. With continued mixture leaning, lean-combustion misfire will occur with eventual engine shutdown.

Typically, for detonation, the intensity is greater between best power and peak EGT mixture settings. Leaning from best power to peak EGT typically results in increasing detonation intensity, until the mixture settings are slightly rich of peak EGT. Leaning beyond peak EGT typically results in significantly reduced power and decreasing detonation intensity.

The relative performance of the blends was compared to one another, as well as to a minimum specification 100LL.

The richest mixture in which detonation onset occurred was used for comparison when rating the blend's knock performance. The blends relative detonation performance was determined based on detonation-limited fuel flow, BSFC, equivalence ratio, air-to-fuel ratio, and average EGT.

Table 14 shows the tight control of test engine parameters. All the conditions were controlled to minimize the effect on test conditions and to ensure repeatability of results.

Table 14. Engine Test Parameters Control

Parameter	Target	Average	Standard Deviation	Maximum	Minimum
Inlet air temperature	103° ±3°F	104.3	1.1	108	100
Maximum CHT	475° +10°F	475.8	1.6	485	472
Other CHTs	within 50°F of maximum CHT	453.9	7.4	469	436
Inlet air pressure - local	<0.04 inHg	0.01	0.03	-0.03	0.01
Inlet air humidity ratio	<5 Gr/lb	0.4	0.4	8.8	-0.1
Oil temperature	245° ±10°F	235.8	7.9	248	192

CHT = Cylinder head temperature
Gr/lb = Grains of moisture per pound of dry air
inHg = Inch of Mercury

The tight test engine parameter control resulted in excellent repeatability of results, as shown in table 15. The average standard deviation as a percentage of the mean value was less than 1.4% for all five detonation-onset parameters.

Table 15. Detonation Onset Repeatability

	FF (lb/hr)	Equivalence Ratio	Air-to-Fuel Ratio	BSFC (lb/hp hr)	EGT (°F)
Average Standard Deviation	1.35	0.01	0.12	0.01	7.68
Maximum Standard Deviation	4.31	0.04	0.48	0.02	26.75
Average Difference (Maximum-Minimum)	3.07	0.03	0.28	0.01	17.48
Maximum Difference (Maximum-Minimum)	8.80	0.07	0.85	0.04	45.67
Average Relative Standard Deviation (% of mean)	1.33	1.08	1.08	1.28	0.57
Maximum Relative Standard Deviation (% of mean)	4.01	3.68	3.64	3.41	1.72

Table 16 shows the best performing blends, using detonation-onset FF as the measuring parameter. It is noted that blend 6 exhibited no detonation at the 2600-rpm setting and blends 6, 28, 31, 3, 2, and 5 attained the maximum allowable EGT of 1650ºF at the 2700-rpm condition prior to the detonation-onset and the test was aborted. The best performing blends all had MONs above 102.6 and the only blends that did not detonate across all power and mixture settings were blends 21 and 15, both having MONs above 106. It should be noted that this test may have resulted in the operation of this engine outside of conditions required for detonation certification testing regarding mixture strength. Testing at these conditions was a necessity to provide input data to a multiple-regression model for engine detonation performance prediction based on unleaded composition.

Table 16. Detonation-Onset Parameters for the Best Performing Blends

Blend	MON (ASTM D 2700)	BHP	Average FF (lb/hr)	Average Equivalence Ratio	Average Air-to-Fuel ratio	Average BSFC (lb/hp hr)	Average EGT (°F)
15	106.3	No detonation at any power setting					
21	106.2	No detonation at any power setting					
6	106.0	188.3	82.0	1.011	14.34	0.436	1550
28	106.0	203.9	89.0	1.027	14.10	0.437	1563
31	105.6	205.2	90.6	1.033	13.80	0.441	1562
3	105.3	200.2	93.3	1.023	13.16	0.466	1567
8	105.0	219.5	99.2	1.039	13.84	0.451	1551
2	104.8	202.3	90.1	1.020	14.04	0.444	1555
41	104.8	219.3	100.9	1.040	13.45	0.459	1578
20	104.2	221.7	107.7	1.060	12.91	0.485	1544
5	104.1	207.9	97.5	1.073	13.19	0.469	1519
37	104.1	225.4	105.4	1.088	13.27	0.467	1521
14	104.0	222.1	105.6	1.057	12.82	0.474	1558
26	104.0	224.8	108.3	1.095	12.76	0.481	1522
10	103.9	220.6	104.3	1.055	13.08	0.472	1548
4	103.9	222.8	101.2	1.074	13.45	0.454	1531
35	103.8	224.5	104.0	1.097	13.21	0.463	1525
7	103.4	224.7	106.4	1.110	13.02	0.473	1498
24	103.3	224.0	112.4	1.124	12.37	0.502	1497
23	103.0	225.0	110.8	1.111	12.66	0.491	1496
36	103.0	226.3	109.0	1.129	12.88	0.480	1488
44	102.9	224.8	117.1	1.153	11.80	0.519	1491
16	102.8	226.8	107.4	1.116	13.04	0.473	1499
17	102.7	226.0	112.7	1.133	12.37	0.498	1479
27	102.7	227.1	110.0	1.142	12.74	0.483	1478
43	102.6	225.5	110.3	1.130	12.68	0.488	1496
Min Spec 100LL	100.6	227.1	109.0	1.178	12.66	0.478	1463

Min Spec = Minimum specification

The average detonation-onset FF, equivalence ratio, air-to-fuel ratio, BSFC, and EGT for all 47 blends are shown in tables 17 and 18. These values were averaged over all four power settings. Blends 15 and 21 did not exhibit repeatable detonation onset at any power setting over any mixture setting. Other blends such as blend 5 reached maximum allowable EGT prior to the detonation-onset at the 2700-rpm condition and therefore a BHP setting was not used at the maximum power setting in the averaged value. This is the reason that the BHP and FF values are less than the values for fuels with slightly lower MONs.

Table 17. Average Detonation-Onset Values for Blends 1 Through 24

Blend	MON (ASTM D 2700)	BHP	FF (lb/hr)	Equivalence Ratio	Air-to-Fuel Ratio	BSFC (lb/hp hr)	EGT (°F)
1	99.7	221.7	127.8	1.280	10.84	0.575	1401
2	104.8	202.3	90.1	1.020	14.04	0.444	1555
3	105.3	200.2	93.3	1.023	13.16	0.466	1567
4	103.9	222.8	101.2	1.074	13.45	0.454	1531
5	104.1	207.9	97.5	1.073	13.19	0.469	1519
6	106.0	188.3	82.0	1.011	14.34	0.436	1550
7	103.4	224.7	106.4	1.110	13.02	0.473	1498
8	105.0	219.5	99.2	1.039	13.84	0.451	1551
9	102.5	224.3	114.5	1.133	12.08	0.509	1494
10	103.9	220.6	104.3	1.055	13.08	0.472	1548
11	99.8	222.8	128.0	1.246	11.05	0.574	1418
12	101.1	224.2	122.0	1.214	11.55	0.543	1434
13	101.2	225.6	117.9	1.202	11.97	0.521	1436
14	104.0	222.1	105.6	1.057	12.82	0.474	1558
15	106.3	---	---	---	---	---	---
16	102.8	226.8	107.4	1.116	13.04	0.473	1499
17	102.7	226.0	112.7	1.133	12.37	0.498	1479
18	99.6	223.5	125.1	1.249	11.49	0.559	1406
19	97.6	222.1	131.0	1.286	10.96	0.589	1381
20	104.2	221.7	107.7	1.060	12.91	0.485	1544
21	106.2	---	---	---	---	---	---
22	100.5	225.0	121.6	1.219	11.74	0.540	1427
23	103.0	225.0	110.8	1.111	12.66	0.491	1496
24	103.3	224.0	112.4	1.124	12.37	0.502	1497

Table 18. Average Detonation-Onset Values for Blends 25 Through 47 and for the Minimum Specification 100LL

Blend	MON (ASTM D 2700)	BHP	FF (lb/hr)	Equivalence Ratio	Air-to-Fuel Ratio	BSFC (lb/hp hr)	EGT (°F)
25	101.0	224.4	121.4	1.240	11.81	0.540	1408
26	104.0	224.8	108.3	1.095	12.76	0.481	1522
27	102.7	227.1	110.0	1.142	12.74	0.483	1478
28	106.0	203.9	89.0	1.027	14.10	0.437	1563
29	100.2	225.2	123.2	1.243	11.81	0.546	1402
30	97.6	222.2	130.5	1.330	11.02	0.586	1362
31	105.6	205.2	90.6	1.033	13.80	0.441	1562
32	98.8	224.5	127.1	1.280	11.27	0.564	1390
33	101.1	225.5	120.8	1.223	11.56	0.534	1437
34	98.8	222.6	129.5	1.269	10.84	0.581	1410
35	103.8	224.5	104.0	1.097	13.21	0.463	1525
36	103.0	226.3	109.0	1.129	12.88	0.480	1488
37	104.1	225.4	105.4	1.088	13.27	0.467	1521
38	100.6	224.4	127.0	1.241	11.06	0.564	1428
39	100.4	223.1	127.9	1.263	11.06	0.573	1403
40	102.0	223.5	121.3	1.224	11.54	0.541	1430
41	104.8	219.3	100.9	1.040	13.45	0.459	1578
42	101.5	224.1	120.3	1.190	11.55	0.536	1461
43	102.6	225.5	110.3	1.130	12.68	0.488	1496
44	102.9	224.8	117.1	1.153	11.80	0.519	1491
45	101.1	224.9	118.6	1.204	11.82	0.526	1456
46	98.2	221.1	132.5	1.353	11.09	0.597	1343
47	99.8	221.9	135.1	1.316	10.66	0.607	1370
Min Spec 100LL	100.6	227.1	109.0	1.178	12.66	0.478	1463

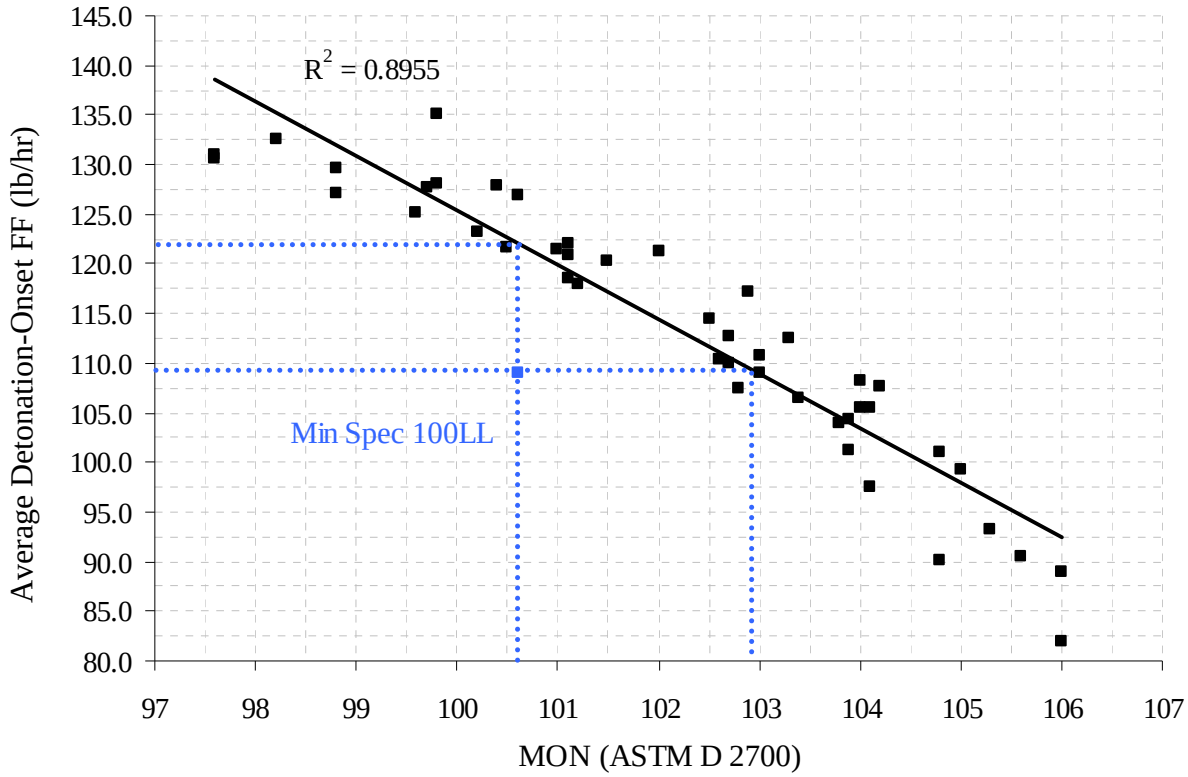
Min Spec = Minimum specification

Sections 3.2 through 3.6 show data for the comparison of the blends based on detonation-onset FF, air-to-fuel ratio, equivalence ratio, EGT, and BSFC, respectively.

3.2 DETONATION PERFORMANCE OF BLENDS BASED ON DETONATION-ONSET FF.

Based on the FF, figure 3 shows the correlation of the detonation performance to the MON of the 47 blends. There was good correlation of the detonation-onset response to the blends' MON. The blue dotted lines show the performance of the minimum specification 100LL. Using the FF

as a guide, the unleaded blends required approximately 102.9 MON for equivalent detonation performance to the minimum specification 100LL with a MON of 100.6. Unleaded blends of equivalent MON to the minimum specification 100LL required an increase in FF of at least 12 lb/hr to prevent detonation. The data shows that none of the unleaded blends of equivalent or lower MON performed as well as the 100LL.



Min Spec = Minimum specification

Figure 3. Correlation of Detonation-Onset FF to the Blend MON

Previous tests at the FAA Technical Center on 30 unleaded blends (MF1) was recorded in report DOT/FAA/AR-04/25, "Full-Scale Engine Knock Tests of 30 Unleaded, High-Octane Blends." Figure 4 shows the detonation-onset FF difference for those 30 blends and the 47 blends (MF2) tested in this report from that of the specially blended 100LL versus the MON of the unleaded fuel blends. Thus, the value of 0 refers to equivalent performance, based on FF, to the minimum specification 100LL. The figure shows that the unleaded fuels required approximately 103.3 MON for equivalent engine performance to the minimum specification 100LL having an MON of 100.6.

Using all 77 blends, the correlation was very high (0.84) between the blends' MON and the detonation-onset FF. Again, the data shows that none of the blends with equivalent or lower MON to the 100LL minimum specification fuel (100.6) performed as well as the 100LL based on the detonation-onset FF method.

It is noted that some of the data for a given MON range showed more scatter than would otherwise be recognized due to the averaging method used. As previously discussed, blends 6,

28, 31, 3, 2, and 5 reached maximum allowable EGT at the 2700-rpm condition prior to reaching detonation, and the 2700-rpm condition was left out of the average. Therefore, the averaged detonation-onset values are artificially lower for these blends.

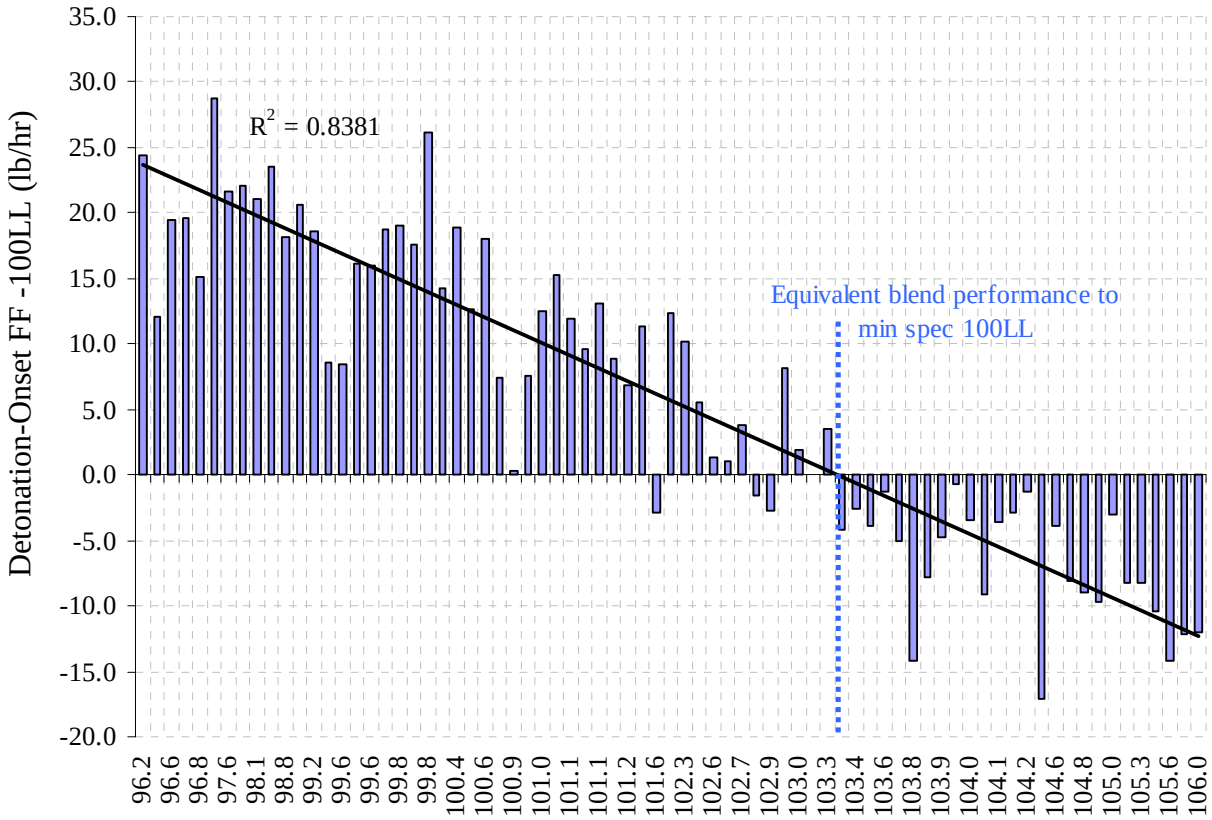


Figure 4. Correlation of Detonation-Onset FF to the Blend MON for the 30 MF1 and 47 MF2 Blends

3.3 DETONATION PERFORMANCE OF BLENDS BASED ON DETONATION-ONSET AIR-TO-FUEL RATIO.

There was good correlation of the blends' detonation-onset air-to-fuel ratio to the respective MON, as shown in figure 5. The data show that none of the unleaded blends of equivalent or lower MON performed as well as the 100LL. The equivalent unleaded detonation performance to the minimum specification 100LL required a MON of 103. The equivalent unleaded performance required an air-to-fuel ratio that was one number lower (richer mixture) than the 100LL. This method illustrates the increase in FF required above the 100LL for the equivalent detonation performance, but does not consider chemically correct air-to-fuel ratio differences of the unleaded blends.

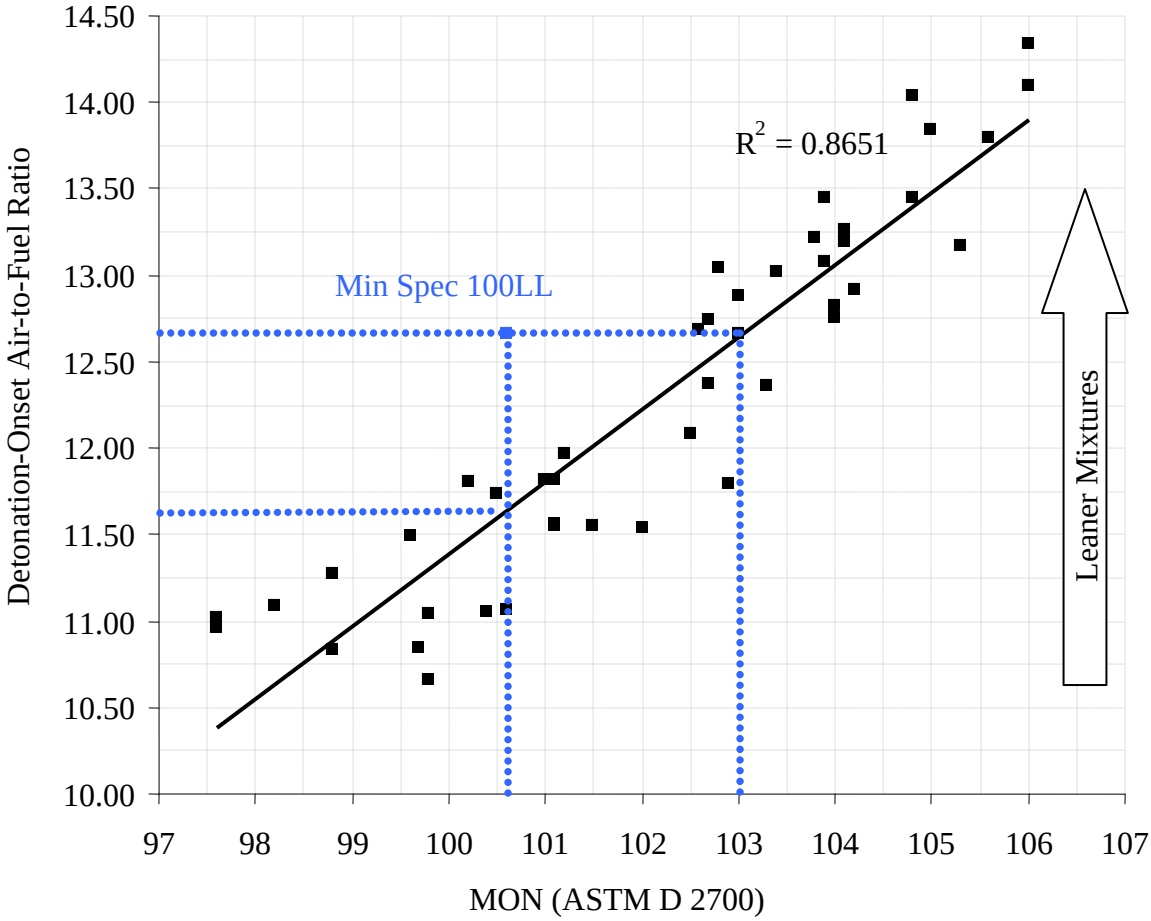


Figure 5. Correlation of Detonation-Onset Air-to-Fuel Ratio to the Blend MON

3.4 DETONATION PERFORMANCE OF BLENDS BASED ON DETONATION-ONSET EQUIVALENCE RATIO.

The detonation-onset equivalence ratio for the 47 blends shown in figure 6 showed better correlation than the air-to-fuel ratio to the blends' MON. This was expected as the use of oxygenates, such as ETBE, up to 30% by volume (v/v), will significantly affect the blends stoichiometry. The data show that none of the unleaded blends of equivalent or lower MON performed as well as the 100LL. The unleaded MON of roughly 101.8 showed equivalent performance to the minimum specification 100LL. This is a lower unleaded fuel MON than determined using either the FF or the air-to-fuel ratio. For an equivalent unleaded MON the detonation onset occurred at an average equivalence ratio that was 0.05 higher (richer mixture) for the unleaded blends than the 100LL.

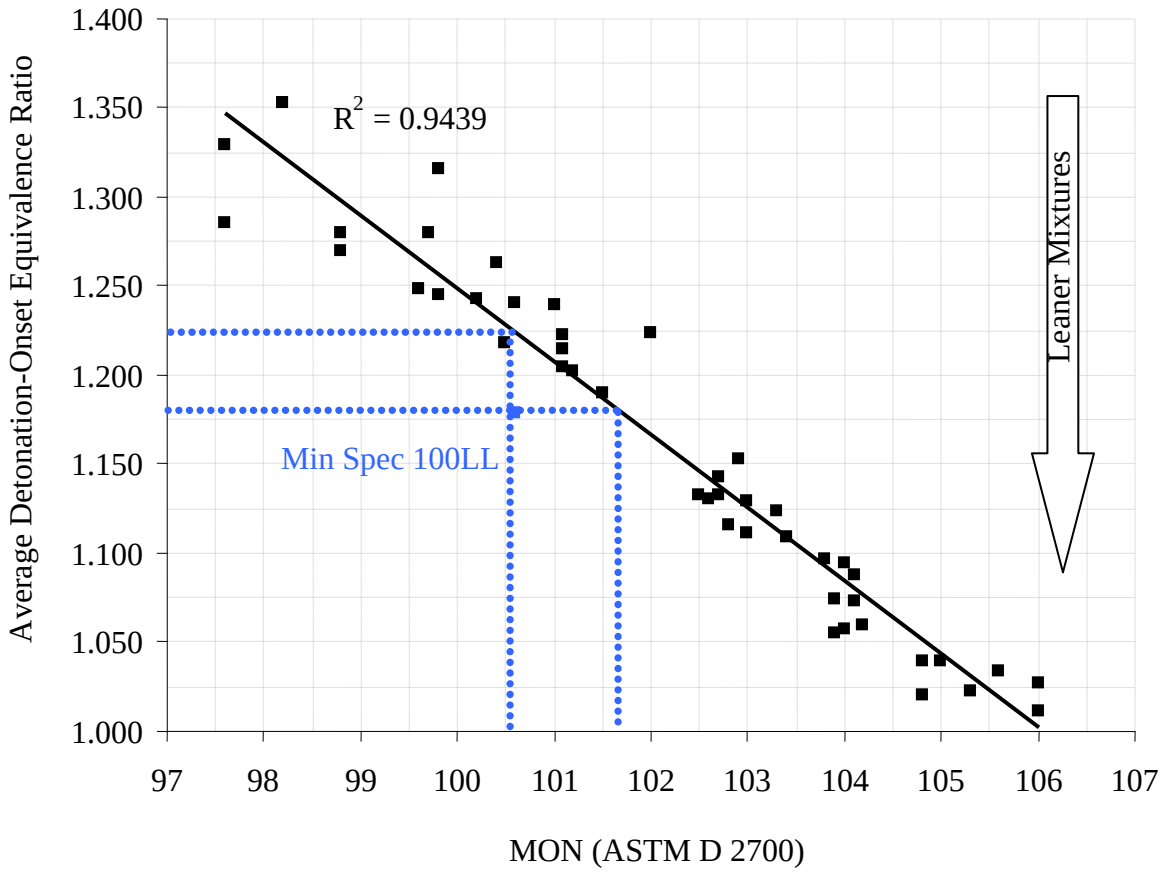


Figure 6. Correlation of Detonation-Onset Equivalence Ratio to the Blend MON

3.5 DETONATION PERFORMANCE OF BLENDS BASED ON DETONATION-ONSET AVERAGE EGT.

The average EGT at detonation onset (shown in figure 7) showed excellent correlation with the unleaded blends' MON, and better correlation than the air-to-fuel ratio for the same reason that the equivalence ratio showed excellent correlation. The data show that none of the unleaded blends of equivalent or lower MON performed as well as the 100LL. The equivalent unleaded blend performance to the minimum specification 100LL required a MON of 101.8 for the unleaded blends. The average EGT at detonation onset was 30ºF lower for the unleaded blends than for the minimum specification 100LL.

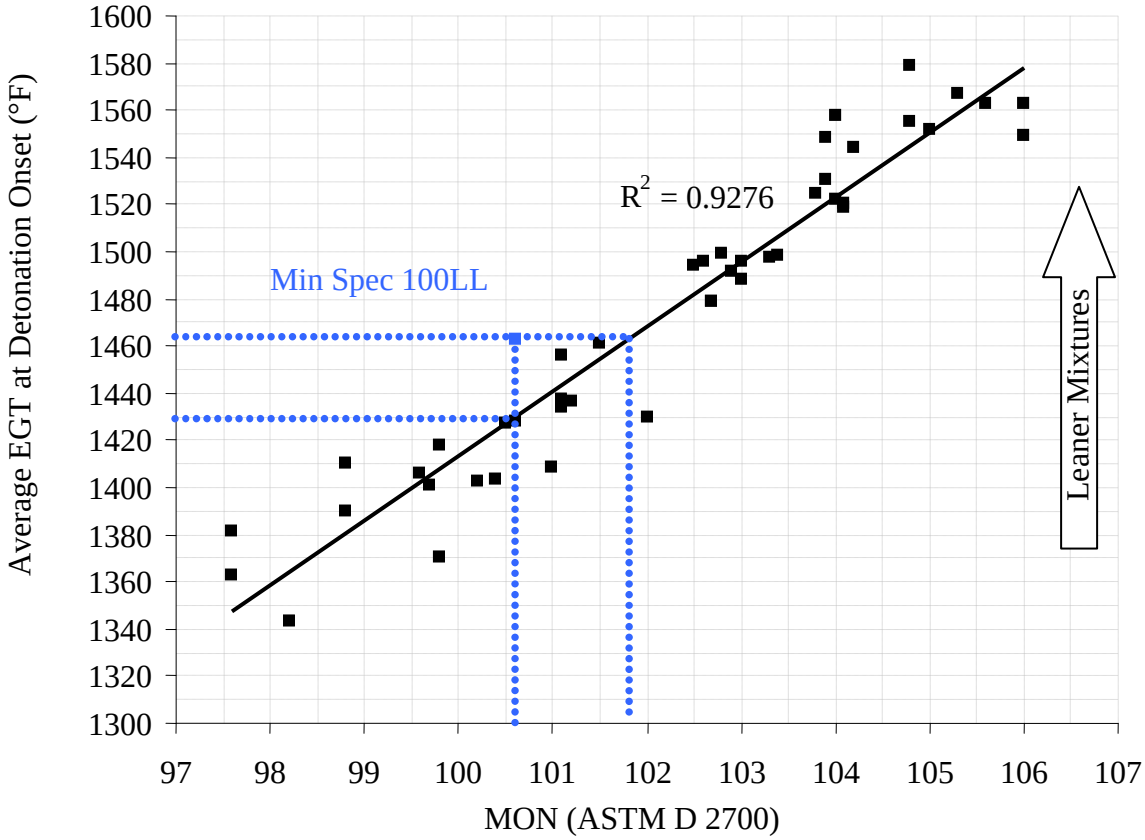


Figure 7. Average EGT at Detonation Onset

3.6 DETONATION PERFORMANCE OF BLENDS BASED ON DETONATION-ONSET BSFC.

The BSFC takes into account both the fuel flow and the BHP and is a measure of engine output efficiency. The lower the BSFC, the greater the power output for a given unit of fuel and, thus, the better the output efficiency. The detonation-onset BSFC shown in figure 8 showed excellent correlation with the MON of the fuel. The data show that none of the unleaded blends of equivalent or lower MON performed as well as the 100LL. The equivalent detonation-onset performance of the unleaded blends to the minimum specification 100LL required an unleaded fuel MON of approximately 103.8. The equivalent detonation performance of the unleaded blends to the 100LL occurred at a much higher BSFC of 0.550 for the unleaded blends as opposed to 0.475 for the 100LL. Based on the equivalence ratio data previously discussed, many of these unleaded blends have significantly lower heating values than the 100LL, which would explain some of the reduced efficiency.

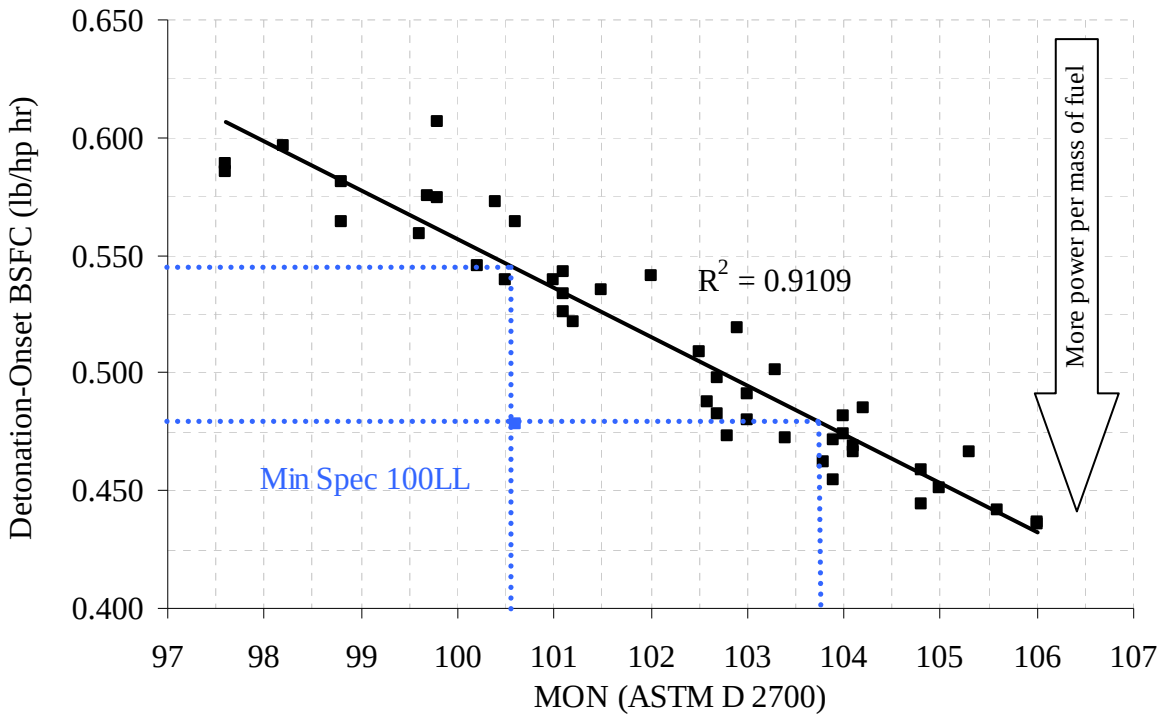


Figure 8. Correlation of Detonation-Onset BSFC to the Blend MON

Table 19 shows the correlations of different detonation-onset parameters to the MON of the blend. The table shows that the detonation-onset equivalence ratio demonstrated the best correlation to the blends' MON, followed by the average EGT and then the BSFC. The detonation-onset air-to-fuel ratio had the lowest R^2 correlation coefficient; however, this value was still very high at 0.865. The correlation between the equivalence ratio and average EGT at detonation onset was also very high.

Table 19. Summary of R^2 Correlation Coefficients for Detonation-Onset Parameters

	MON (ASTM D 2700)	Equivalence Ratio	Air-to-Fuel Ratio	FF (lb/hr)	BSFC (lb/hp hr)	EGT (°F)
MON (ASTM D 2700)	----	0.944	0.865	0.895	0.911	0.928
Equivalence Ratio	0.944	----	0.900	0.919	0.944	0.981
Air-to-Fuel Ratio	0.865	0.900	----	0.954	0.961	0.842
FF (lb/hr)	0.895	0.919	0.954	----	0.934	0.868
BSFC (lb/hp hr)	0.911	0.944	0.961	0.934	----	0.907
EGT (°F)	0.928	0.981	0.842	0.868	0.907	----

Table 20 shows the equivalent MON needed for the unleaded blends for equivalent performance to the leaded aviation gasolines. Columns 3 through 7 show the different detonation-onset comparison methods used. Column 8 shows the equivalent MON for the blends averaged for all the methods used. For the unleaded blends' to provide equivalent detonation performance to the minimum specification 100LL, an average of 2 MON higher was required. For the unleaded blends equivalent performance to the fixed base operator 100LL, 1.4 MON higher, on average, was required. This suggests that there was a reduced unleaded fuel MON increment as the MON of the 100LL blend was increased. A possible explanation is that the MON increment between leaded and unleaded fuels at the high-octane, high-aromatic amine levels becomes smaller. It may also be because at high MON levels of 104 and above, the propensity of this engine to detonate at any condition is greatly diminished. This test showed that the engine did not detonate at any of the extreme conditions on the 106 MON blends.

Table 20. MON of Unleaded Blends for Equivalent Detonation Performance to the Leaded Aviation Gasolines

		MON (ASTM D 2700) of 47 Blends					
	MON (ASTM D 2700)	FF (lb/hr)	BSFC (lb/hp hr)	Eq R	Average EGT (°F)	Air-to-Fuel Ratio	Mean
Min Spec 100LL	100.6	102.9	103.8	101.7	101.8	103.0	102.6
FBO 100LL	103.6	105.7	106.0	104.0	103.8	105.6	105.0

Min Spec = Minimum specification
Eq R = Equivalence ratio
FBO = Fixed base operator

3.7 THE MON OF BLENDS BASED ON BLEND COMPOSITION.

Figure 9 shows the comparison of the meta-Toluidine content to the blends' MON. This is a first-order, linear correlation and it shows the dominance of the meta-Toluidine on the MON of the blend. Similar linear correlations performed on the blends did not show the same trend as the other components (see table 21). More sophisticated multiple-regression analyses are still to be done on the blends' composition. These advanced, higher-order analyses will provide insight into individual and synergistic component contributions to both the blends' MON and to the blends' full-scale engine performance.

The dominance of the meta-Toluidine on blend MON and engine satisfaction was expected as this component is an ASTM unleaded, high-octane reference fuel component and has a very high individual MON.

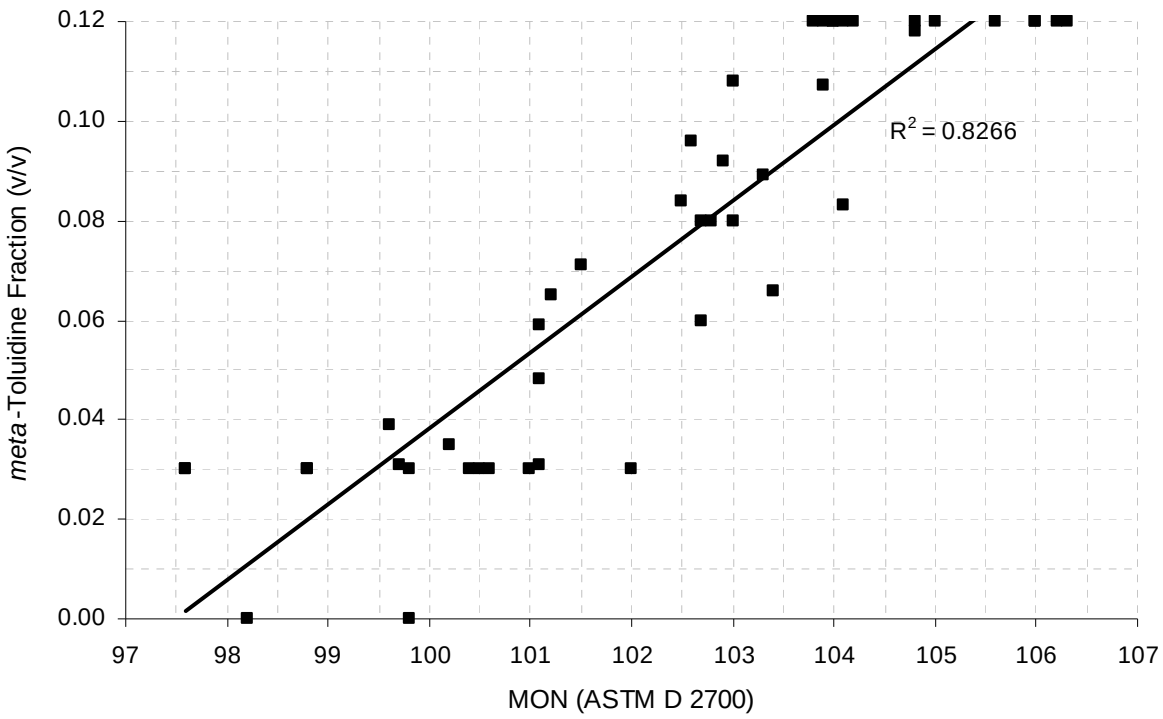


Figure 9. meta-Toluidine Content Effect on MON

Table 21. First-Order, Linear Correlation Coefficients Between Blend Composition and Blend MON (r-Values)

	Aviation Alkylate	Super Alkylate	Toluene	tert-Butylbenzene	ETBE	meta-Toluidine
MON (ASTM D 2700)	0.217	0.136	0.049	0.067	0.152	0.909

3.8 DETONATION PERFORMANCE OF BLENDS BASED ON BLEND COMPOSITION.

This section discusses the initial investigation of the fuel composition on engine detonation performance. As stated in section 3.7, a more sophisticated multiple-regression model will be applied to the engine detonation-onset results, which will show the individual and synergistic compositional effects on the engine detonation performance. The dominance of the meta-Toluidine on engine satisfaction was expected along with the results shown in section 3.7. Again, this component is an ASTM unleaded, high-octane reference fuel component and has a very high individual MON.

Figures 10 through 16 show the first-order, linear plot of fuel component fraction to the full-scale engine satisfaction. The results again show the dominance of the meta-Toluidine on the full-scale engine behavior. This dominance has masked the individual effects of the other components on the detonation performance. Figure 17 shows the meta-Toluidine correlation to the engine detonation performance for both the 47 blends discussed in this report and the 30 blends previously tested.

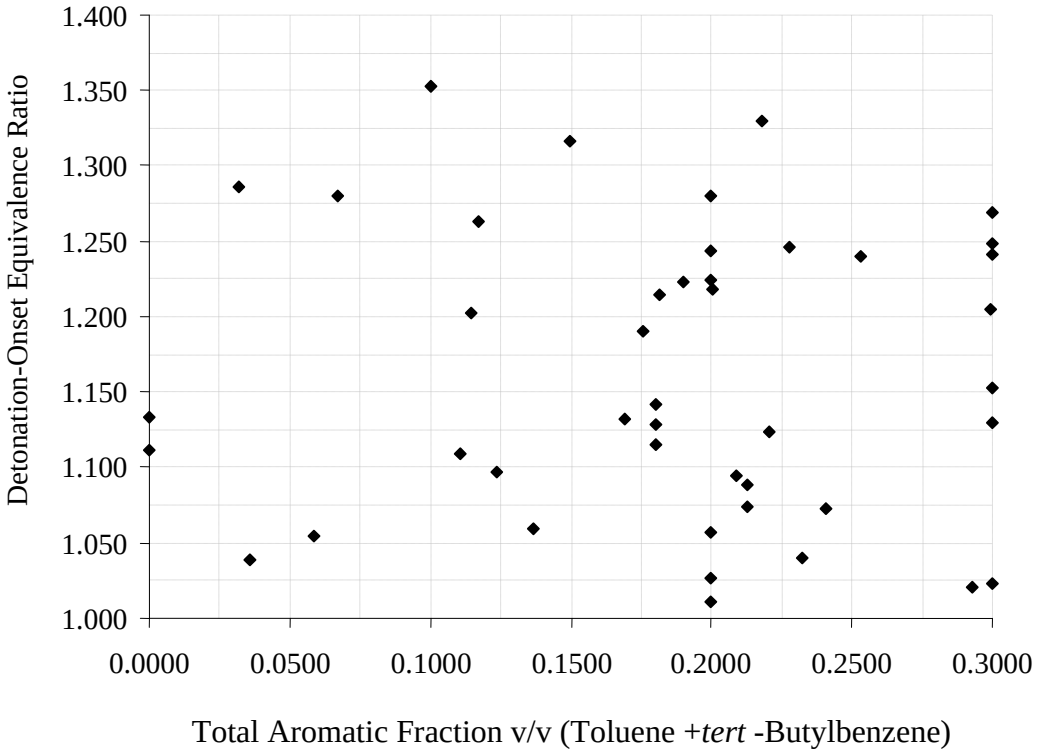


Figure 10. Effect of Total Aromatic Fraction on the Detonation-Onset Equivalence Ratio

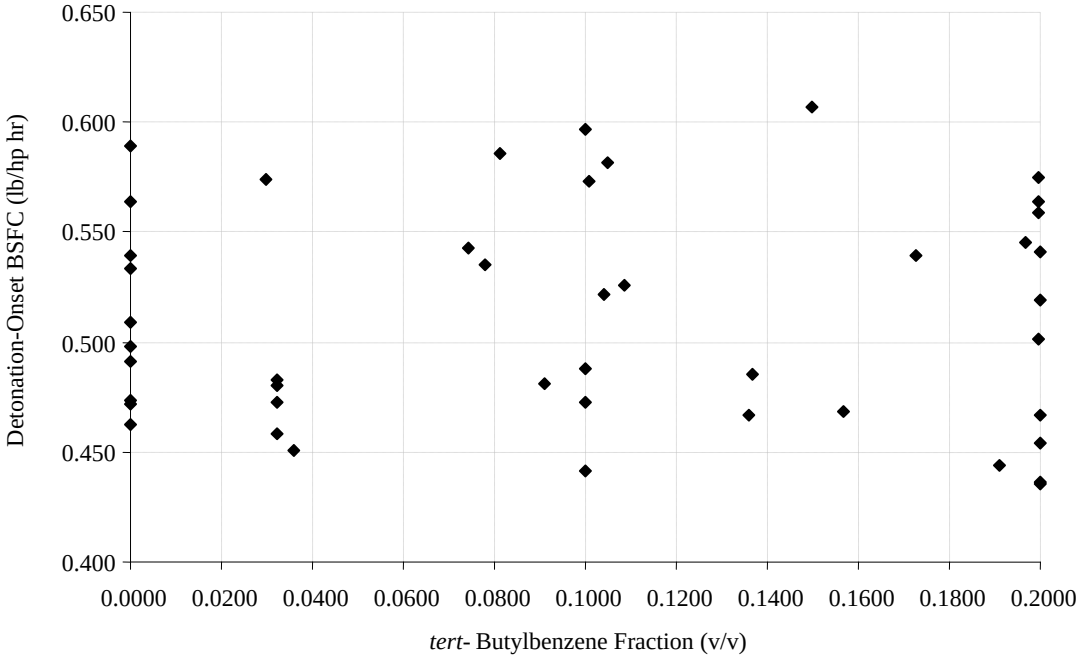


Figure 11. Effect of tert-Butylbenzene Fraction on Detonation-Onset BSFC

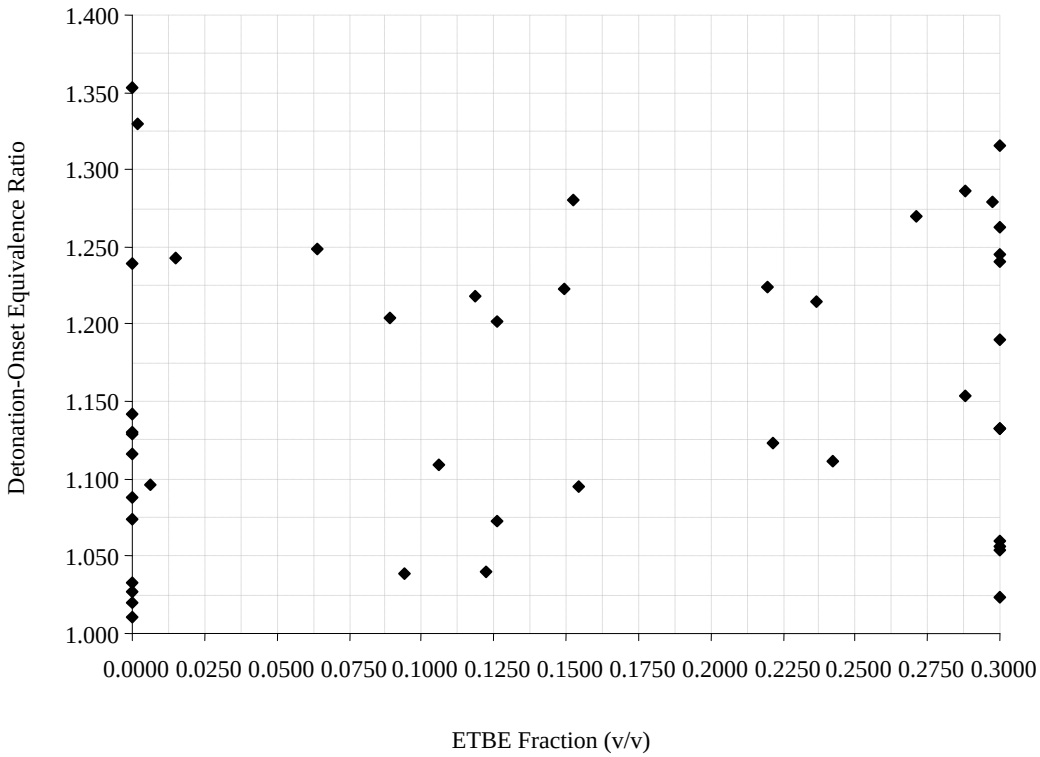


Figure 12. Effect of ETBE Fraction on Detonation-Onset Equivalence Ratio

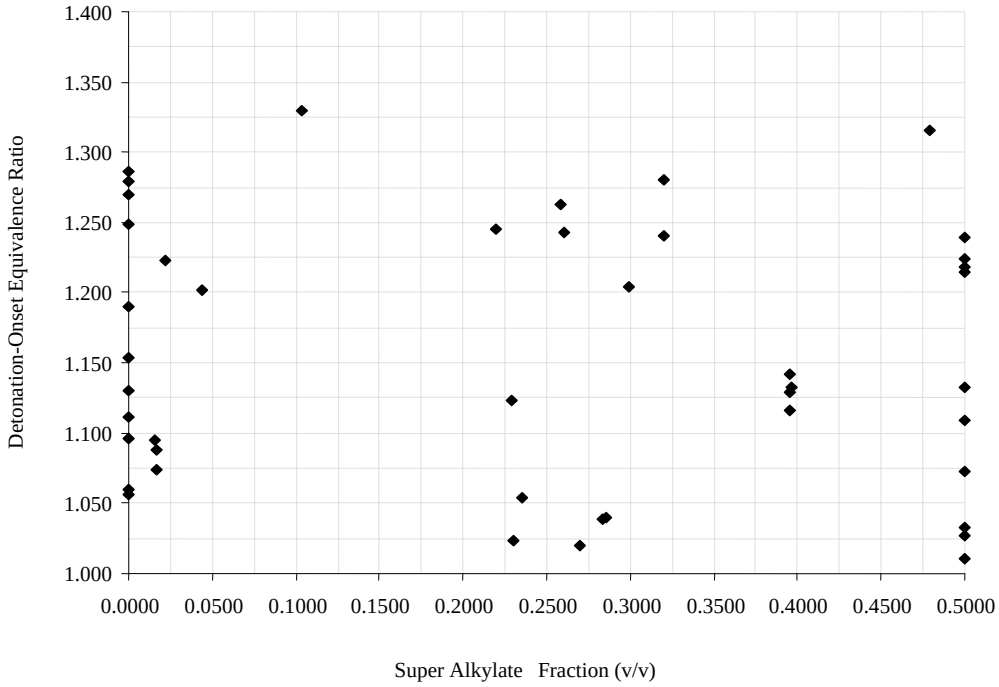


Figure 13. Effect of Super Alkylate Fraction on Detonation-Onset Equivalence Ratio

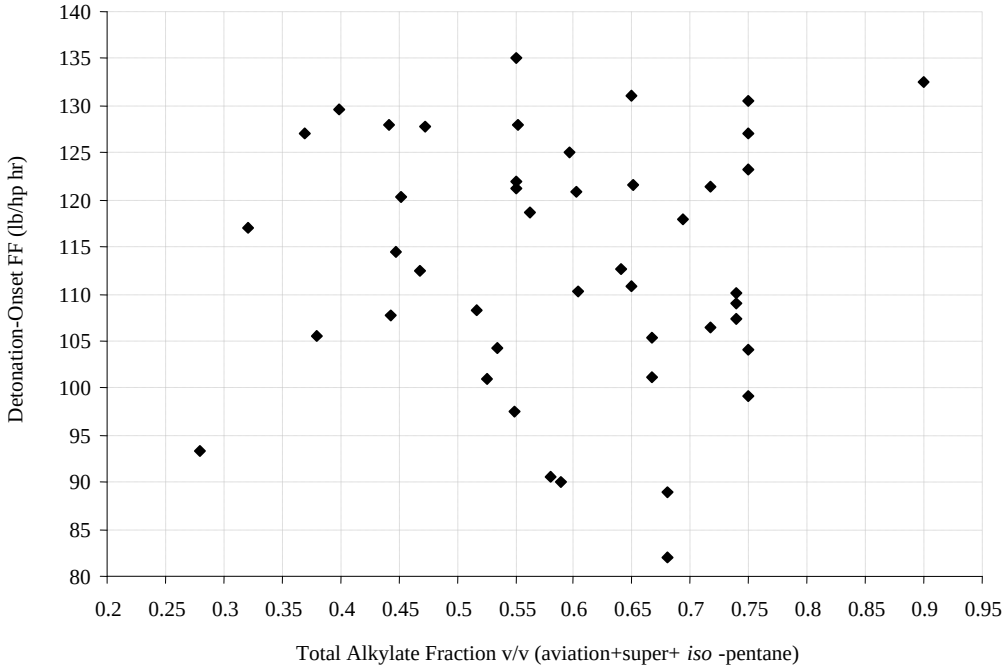


Figure 14. Effect of Total Alkylate Fraction on Detonation-Onset FF

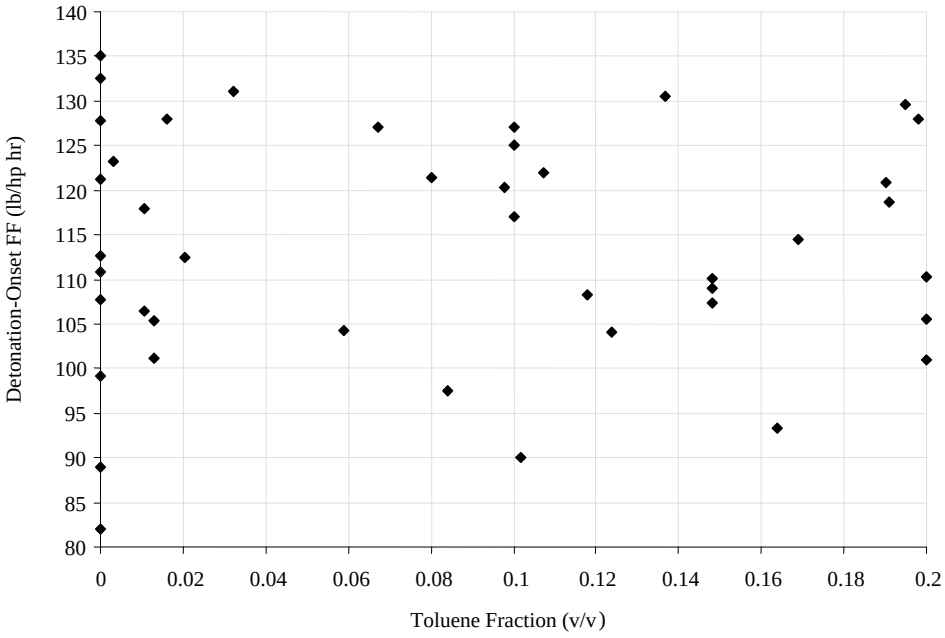


Figure 15. Effect of Toluene Fraction on Detonation-Onset FF

Figures 16 through 19 show the effect of the composition of meta-Toluidine on engine detonation performance. Figure 16 shows that all of the blends, except for two that had meta-Toluidine fractions greater than 0.06, performed better than the minimum specification 100LL, irrespective of the other component fractions. Figure 17 shows that using the air-to-fuel ratio as the measure, all the blends except for two with meta-Toluidine fractions greater than 0.085, showed better detonation performance than the minimum specification 100LL. Figure 18 shows the composition of the meta-Toluidine detonation performance based on the BSFC for both the 47 blends tested in this report and the 30 blends tested previously. None of the blends containing less than 6% meta-Toluidine by volume performed as well as the minimum specification 100LL. All 77 blends with greater than 9.5% meta-Toluidine volume percentage performed better than the minimum specification 100LL, except for 3 blends. Figure 19 shows the composition of the meta-Toluidine detonation performance based on the FF for both the 47 blends discussed in this report and the 30 blends tested previously. Of the 47 blends, all but 1 with meta-Toluidine levels greater than 10% by volume performed better than the minimum specification 100LL. Furthermore, six of the blends that had meta-Toluidine volume percentages between 6% and 10% performed better than the minimum specification 100LL. None of the blends with less than 6% meta-Toluidine by volume performed as well as the minimum specification 100LL.

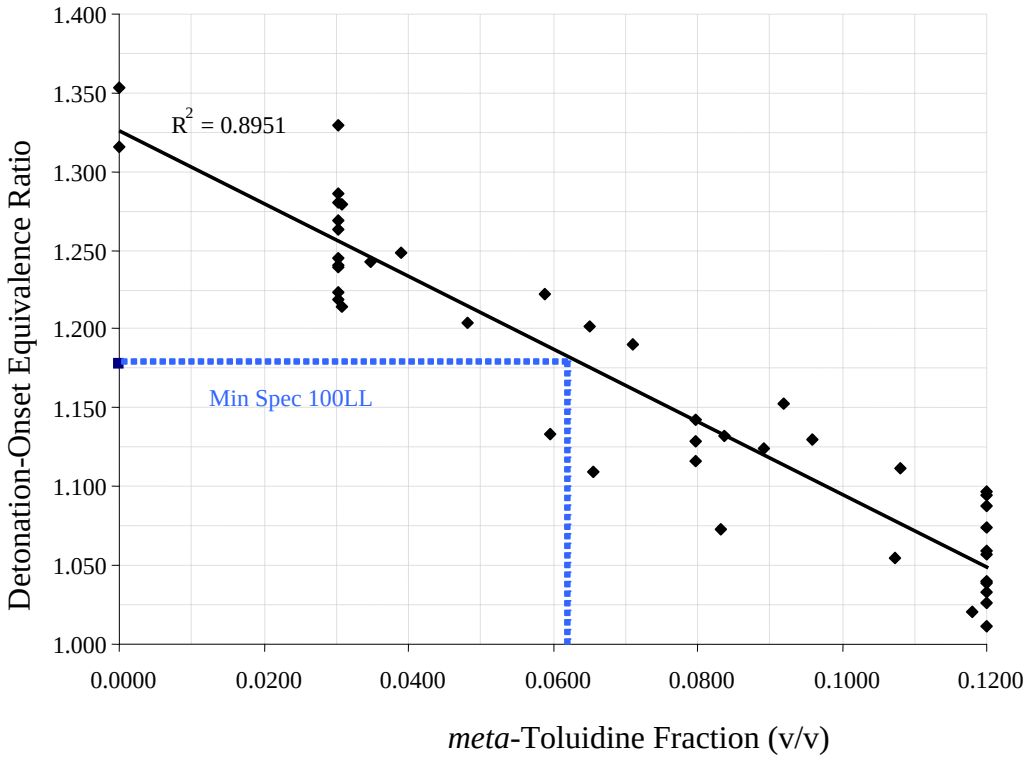


Figure 16. Effect of meta-Toluidine Fraction on Detonation-Onset Equivalence Ratio

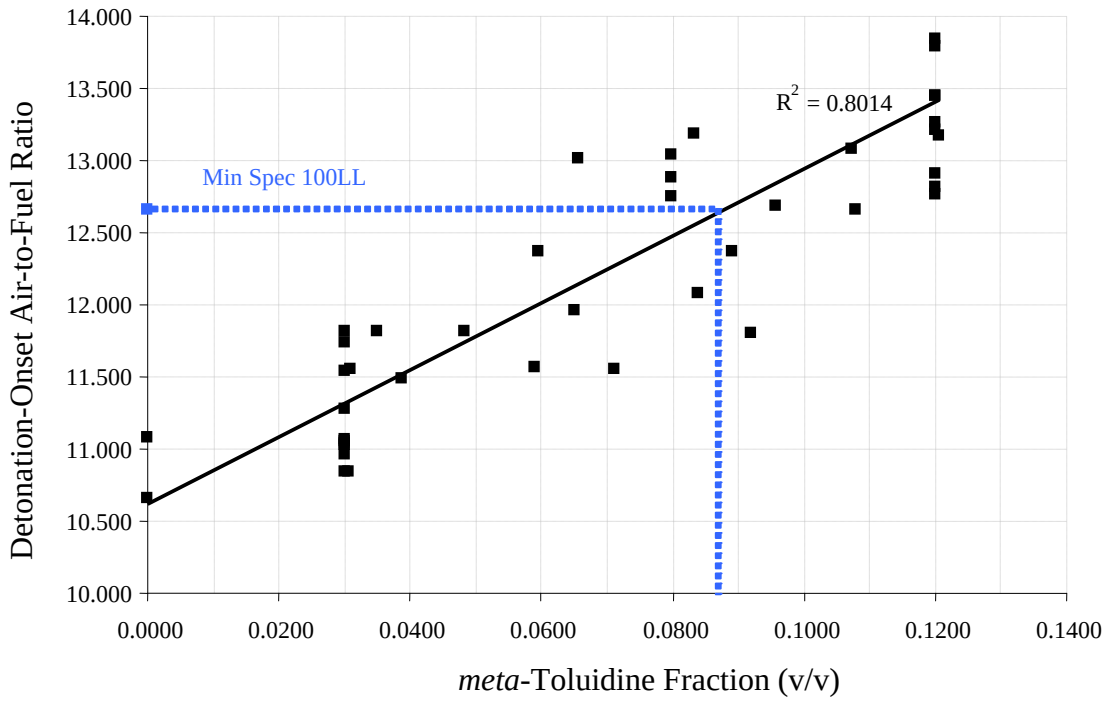


Figure 17. Correlation of the meta-Toluidine Content to the Blends' Detonation-Onset Air-to-Fuel Ratio

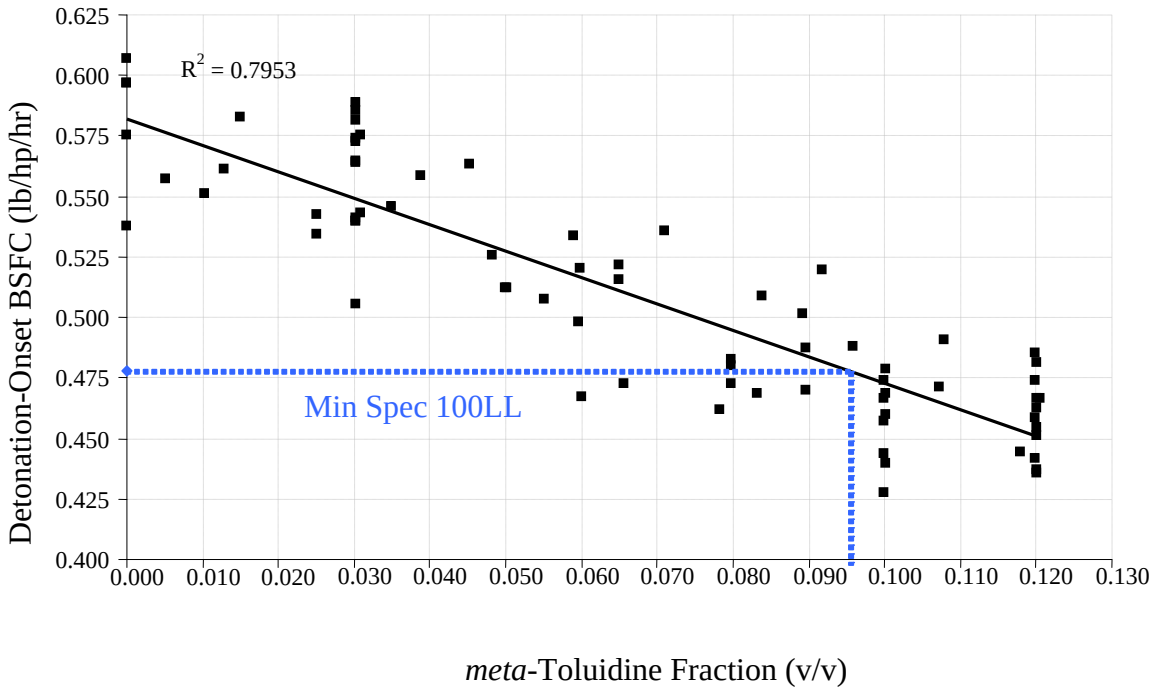


Figure 18. Correlation of the meta-Toluidine Content to the Blends' Detonation-Onset BSFC for all 77 MF1 and MF2 Blends

Figure 19 shows that equivalent performance to the minimum specification 100LL, based on the detonation-onset FF, was attained by the addition of 10% meta-Toluidine. All blends that had 10 volume percent or greater performed equal to or better than the minimum specification 100LL, irrespective of any other blend components. The one fuel with roughly 11% meta-Toluidine shows a slight increase in required FF; however, this is within the repeatability of the test.

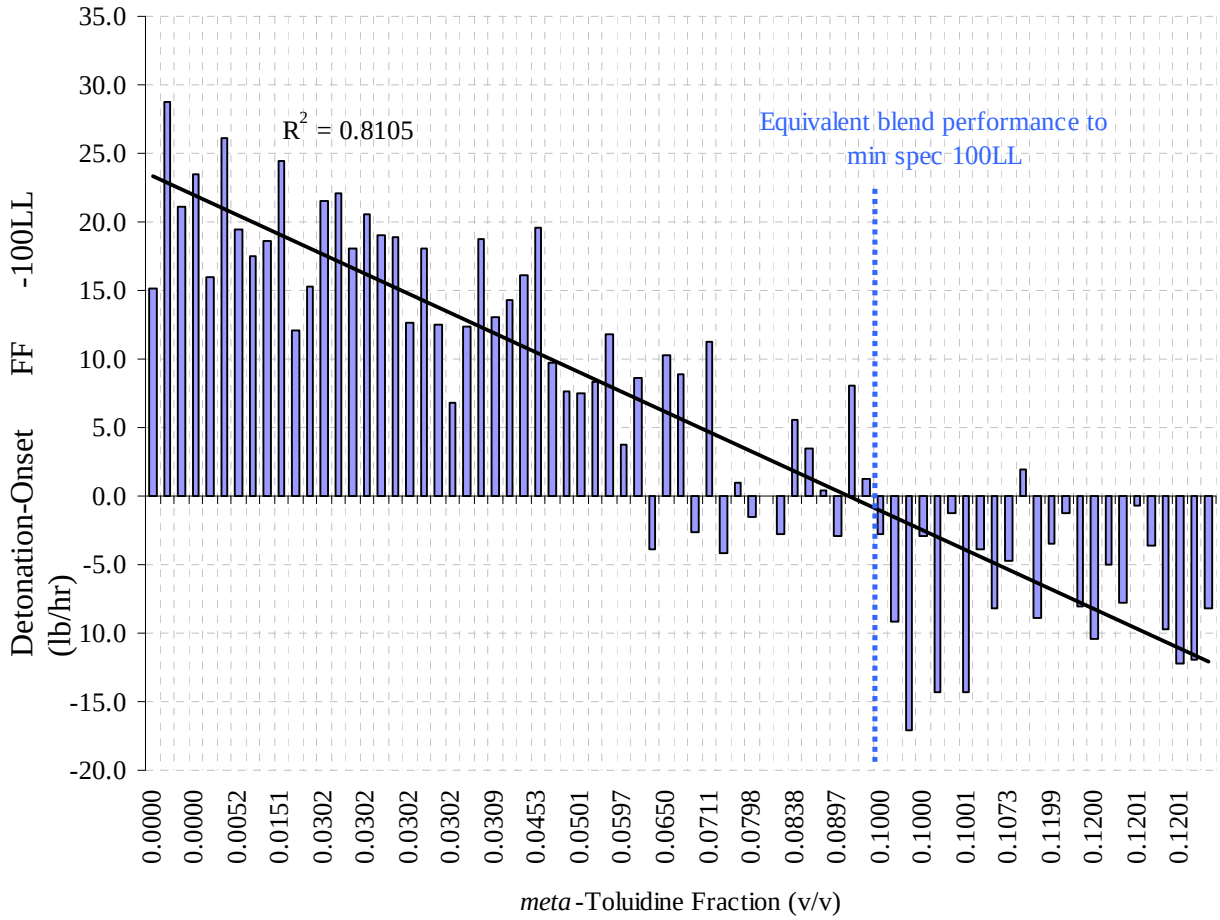


Figure 19. Correlation of the meta-Toluidine Content to the Blends' Detonation-Onset FF for all 77 MF1 and MF2 Blends

3.9 BLEND BEST POWER, PEAK EGT, AND BEST ECONOMY DATA.

3.9.1 BEST POWER DATA.

In tables 22 through 29, DL refers to detonation limited. In this case, the test was aborted due to elevated detonation levels prior to reaching best power mixture. The data is shown for all four power settings. Detailed power data is shown in appendix B.

Table 22. Best Power Data for Blends 1 Through 23, 2700 rpm

Blend	FF (lb/hr)	BHP	Air-to-Fuel Ratio	Equivalence Ratio	BSFC (lb/hp hr)	EGT (°F)
1	DL	DL	DL	DL	DL	DL
2	134.1	267.5	12.12	1.180	0.501	1517
3	139.8	269.0	11.63	1.157	0.52	1540
4	131.7	267.4	12.37	1.166	0.493	1516
5	134.6	268.6	12.19	1.160	0.502	1525
6	134.0	269.8	12.30	1.175	0.497	1515
7	135.0	271.1	12.34	1.170	0.499	1506
8	133.4	268.3	12.40	1.159	0.495	1516
9	140.5	272.5	11.82	1.157	0.518	1527
10	143.3	273.3	11.71	1.176	0.525	1511
11	DL	DL	DL	DL	DL	DL
12	DL	DL	DL	DL	DL	DL
13	DL	DL	DL	DL	DL	DL
14	139.3	276.7	11.95	1.132	0.505	1554
15	137.4	276.7	12.33	1.150	0.497	1532
16	132.9	276.5	12.73	1.142	0.480	1531
17	140.5	278.5	12.11	1.156	0.504	1514
18	DL	DL	DL	DL	DL	DL
19	DL	DL	DL	DL	DL	DL
20	142.2	273.0	11.87	1.153	0.524	1523
21	145.0	275.1	11.66	1.178	0.528	1510
22	DL	DL	DL	DL	DL	DL
23	134.0	273.1	12.45	1.129	0.492	1529

Table 23. Best Power Data for Blends 24 Through 47 and Minimum Specification 100LL, 2700 rpm

Blend	FF (lb/hr)	BHP	Air-to-Fuel Ratio	Equivalence Ratio	BSFC (lb/hp hr)	EGT (°F)
24	147.8	271.2	11.48	1.209	0.545	1484
25	DL	DL	DL	DL	DL	DL
26	138.1	274.0	12.12	1.152	0.505	1528
27	132.3	275.3	12.75	1.140	0.482	1523
28	133.8	271.5	12.54	1.153	0.494	1524
29	149.6	273.0	11.66	1.258	0.548	1440
30	DL	DL	DL	DL	DL	DL
31	139.1	275.3	12.23	1.165	0.506	1520
32	DL	DL	DL	DL	DL	DL
33	DL	DL	DL	DL	DL	DL
34	DL	DL	DL	DL	DL	DL
35	134.1	271.2	12.33	1.174	0.494	1516
36	134.5	274.8	12.76	1.139	0.491	1524

Table 23. Best Power Data for Blends 24 Through 47 and Minimum Specification 100LL, 2700 rpm (Continued)

Blend	FF (lb/hr)	BHP	Air-to-Fuel Ratio	Equivalence Ratio	BSFC (lb/hp hr)	EGT (°F)
37	133.4	276.0	12.73	1.133	0.484	1534
38	151.7	274.3	11.14	1.232	0.554	1480
39	DL	DL	DL	DL	DL	DL
40	143.5	269.7	11.62	1.216	0.534	1476
41	137.0	270.9	12.02	1.164	0.506	1536
42	140.5	273.9	11.87	1.158	0.514	1525
43	138.0	275.9	12.29	1.165	0.506	1523
44	142.3	273.7	11.65	1.167	0.521	1532
45	DL	DL	DL	DL	DL	DL
46	DL	DL	DL	DL	DL	DL
47	DL	DL	DL	DL	DL	DL
Min Spec 100LL	136.5	277.3	12.2	1.221	0.492	1485

Min Spec = Minimum specification

Table 24. Best Power Data for Blends 1 Through 23, 2600 rpm

Blend	FF (lb/hr)	BHP	Air-to-Fuel Ratio	Equivalence Ratio	BSFC (lb/hp hr)	EGT (°F)
1	DL	DL	DL	DL	DL	DL
2	117.7	238.7	12.29	1.164	0.494	1494
3	121.0	235.7	11.79	1.142	0.513	1515
4	115.7	238.5	12.52	1.153	0.486	1491
5	122.1	236.6	11.91	1.187	0.517	1472
6	116.8	238.8	12.53	1.154	0.490	1488
7	120.4	237.7	12.17	1.186	0.507	1460
8	116.2	237.7	12.63	1.139	0.489	1498
9	120.4	236.7	12.07	1.133	0.509	1505
10	120.4	236.0	11.96	1.152	0.510	1492
11	DL	DL	DL	DL	DL	DL
12	122.3	236.5	11.96	1.172	0.517	1476
13	DL	DL	DL	DL	DL	DL
14	124.2	234.7	11.60	1.166	0.528	1492
15	120.9	237.7	12.12	1.169	0.508	1481
16	115.7	238.5	12.62	1.152	0.484	1487
17	117.7	235.7	12.27	1.142	0.500	1485
18	DL	DL	DL	DL	DL	DL
19	DL	DL	DL	DL	DL	DL
20	121.2	235.8	12.16	1.125	0.514	1508
21	120.5	237.0	12.08	1.137	0.508	1498
22	121.5	238.5	12.14	1.177	0.509	1464
23	121.1	239.0	12.34	1.139	0.508	1490

Table 25. Best Power Data for Blends 24 Through 47 and Minimum Specification 100LL, 2600 rpm

Blend	FF (lb/hr)	BHP	Air-to-Fuel Ratio	Equivalence Ratio	BSFC (lb/hp hr)	EGT (°F)
24	117.1	237.4	12.34	1.125	0.496	1510
25	DL	DL	DL	DL	DL	DL
26	119.2	238.3	12.22	1.142	0.500	1500
27	115.9	240.2	12.66	1.149	0.481	1490
28	116.0	237.7	12.63	1.144	0.487	1496
29	121.6	236.8	12.21	1.202	0.515	1438
30	DL	DL	DL	DL	DL	DL
31	117.2	238.2	12.46	1.143	0.492	1503
32	DL	DL	DL	DL	DL	DL
33	116.6	238.4	12.38	1.141	0.490	1498
34	DL	DL	DL	DL	DL	DL
35	120.0	238.7	12.20	1.187	0.504	1476
36	112.9	240.0	12.97	1.121	0.470	1504
37	115.3	238.1	12.71	1.135	0.485	1498
38	DL	DL	DL	DL	DL	DL
39	124.9	237.7	11.77	1.187	0.525	1456
40	120.0	237.8	12.12	1.165	0.503	1476
41	122.5	235.7	11.80	1.184	0.520	1484
42	119.3	236.2	12.09	1.137	0.505	1502
43	114.0	237.6	12.82	1.117	0.480	1511
44	117.7	236.1	12.25	1.109	0.497	1532
45	119.4	237.8	12.22	1.163	0.502	1493
46	DL	DL	DL	DL	DL	DL
47	DL	DL	DL	DL	DL	DL
Min Spec 100LL	113.8	239.0	12.54	1.188	0.477	1471

Min Spec = Minimum specification

Table 26. Best Power Data for Blends 1 Through 23, 2450 rpm

Blend	FF (lb/hr)	BHP	Air-to-Fuel Ratio	Equivalence Ratio	BSFC (lb/hp hr)	EGT (°F)
1	DL	DL	DL	DL	DL	DL
2	102.9	209.7	12.41	1.152	0.490	1470
3	109.1	208.5	11.61	1.159	0.523	1472
4	98.7	210.9	12.91	1.118	0.471	1480
5	101.9	210.5	12.67	1.116	0.484	1482
6	103.5	211.6	12.52	1.155	0.489	1456
7	101.2	211.8	12.79	1.128	0.478	1465
8	102.1	210.8	12.74	1.129	0.485	1468
9	107.4	209.0	11.98	1.141	0.514	1464
10	104.7	209.4	12.27	1.124	0.500	1472

Table 26. Best Power Data for Blends 1 Through 23, 2450 rpm (Continued)

Blend	FF (lb/hr)	BHP	Air-to-Fuel Ratio	Equivalence Ratio	BSFC (lb/hp hr)	EGT (°F)
11	107.5	208.3	11.97	1.149	0.516	1452
12	106.9	209.3	12.09	1.160	0.512	1445
13	100.6	209.7	12.84	1.120	0.480	1462
14	103.9	208.5	12.16	1.113	0.498	1488
15	104.5	210.6	12.37	1.146	0.496	1460
16	99.5	211.9	13.00	1.118	0.470	1473
17	104.6	210.4	12.36	1.134	0.496	1453
18	109.8	209.3	11.98	1.196	0.525	1416
19	DL	DL	DL	DL	DL	DL
20	106.7	208.5	12.21	1.120	0.511	1472
21	105.4	210.0	12.21	1.126	0.502	1474
22	103.2	210.1	12.66	1.130	0.491	1456
23	104.0	209.5	12.45	1.129	0.496	1463

Table 27. Best Power Data for Blends 24 Through 47 and Minimum Specification 100LL, 2450 rpm

Blend	FF (lb/hr)	BHP	Air-to-Fuel Ratio	Equivalence Ratio	BSFC (lb/hp hr)	EGT (°F)
24	102.9	209.8	12.45	1.116	0.491	1480
25	106.5	210.1	12.32	1.188	0.508	1416
26	105.4	210.8	12.25	1.139	0.501	1465
27	97.6	211.8	13.22	1.100	0.461	1484
28	105.3	211.3	12.41	1.165	0.498	1448
29	102.1	211.9	12.77	1.150	0.482	1439
30	108.6	209.4	11.89	1.232	0.519	1395
31	103.0	210.6	12.48	1.141	0.489	1471
32	DL	DL	DL	DL	DL	DL
33	103.0	210.1	12.42	1.138	0.491	1466
34	DL	DL	DL	DL	DL	DL
35	101.1	211.6	12.67	1.143	0.481	1474
36	100.6	211.4	12.87	1.130	0.476	1459
37	103.1	211.0	12.66	1.14	0.489	1463
38	DL	DL	DL	DL	DL	DL
39	108.2	208.9	11.88	1.175	0.518	1432
40	105.4	209.7	12.23	1.155	0.499	1448
41	105.2	211.6	12.24	1.142	0.500	1472
42	104.8	208.5	12.18	1.128	0.505	1470
43	102.8	211.2	12.47	1.148	0.489	1465
44	105.3	209.0	12.10	1.124	0.504	1487
45	105.2	210.9	12.34	1.152	0.499	1462
46	DL	DL	DL	DL	DL	DL
47	DL	DL	DL	DL	DL	DL
Min Spec 100LL	98.7	211.1	12.89	1.156	0.467	1455

Min Spec = Minimum specification

Table 28. Best Power Data for Blends 1 Through 23, 2350 rpm

Blend	FF (lb/hr)	BHP	Air-to-Fuel Ratio	Equivalence Ratio	BSFC (lb/hp hr)	EGT (°F)
1	DL	DL	DL	DL	DL	DL
2	90.0	182.0	12.52	1.142	0.495	1458
3	94.7	180.3	11.71	1.149	0.527	1461
4	87.2	181.9	12.96	1.113	0.481	1460
5	92.9	181.4	12.20	1.159	0.512	1443
6	89.0	182.6	12.73	1.135	0.488	1459
7	87.7	180.3	12.87	1.121	0.487	1453
8	90.1	182.3	12.69	1.133	0.495	1448
9	93.1	180.9	12.11	1.129	0.514	1458
10	94.2	180.3	11.99	1.149	0.524	1445
11	92.3	179.0	12.18	1.128	0.516	1448
12	88.9	181.2	12.66	1.108	0.490	1466
13	89.7	182.2	12.72	1.130	0.492	1445
14	94.4	180.2	11.81	1.146	0.526	1454
15	89.5	181.2	12.58	1.127	0.494	1459
16	85.8	183.0	13.18	1.103	0.469	1469
17	90.0	182.6	12.54	1.117	0.492	1457
18	96.4	181.3	12.00	1.195	0.531	1402
19	DL	DL	DL	DL	DL	DL
20	94.5	181.1	12.15	1.126	0.522	1458
21	94.2	180.6	12.02	1.143	0.521	1448
22	92.9	182.1	12.39	1.154	0.510	1430
23	90.9	182.5	12.50	1.124	0.499	1451

Table 29. Best Power Data for Blends 24 Through 47 and Minimum Specification 100LL, 2350 rpm

Blend	FF (lb/hr)	BHP	Air-to-Fuel Ratio	Equivalence Ratio	BSFC (lb/hp hr)	EGT (°F)
24	92.1	181.3	12.28	1.131	0.510	1459
25	DL	DL	DL	DL	DL	DL
26	90.6	181.3	12.40	1.126	0.500	1462
27	87.6	182.2	12.91	1.126	0.480	1451
28	88.4	182.4	12.87	1.123	0.486	1464
29	DL	DL	DL	DL	DL	DL
30	DL	DL	DL	DL	DL	DL
31	93.8	182.3	12.19	1.169	0.514	1437
32	92.5	182.0	12.26	1.176	0.508	1418
33	90.1	180.9	12.39	1.140	0.498	1452
34	96.5	180.4	11.64	1.181	0.535	1427
35	88.2	181.1	12.68	1.142	0.489	1459
36	88.1	182.4	12.86	1.130	0.482	1457

Table 29. Best Power Data for Blends 24 Through 47 and Minimum Specification 100LL, 2350 rpm (Continued)

Blend	FF (lb/hr)	BHP	Air-to-Fuel Ratio	Equivalence Ratio	BSFC (lb/hp hr)	EGT (°F)
37	87.7	181.7	13.00	1.110	0.483	1467
38	94.2	180.5	11.84	1.159	0.522	1443
39	DL	DL	DL	DL	DL	DL
40	DL	DL	DL	DL	DL	DL
41	92.5	182.2	12.09	1.156	0.509	1456
42	94.9	180.2	11.79	1.165	0.528	1447
43	87.0	181.1	13.02	1.100	0.482	1477
44	93.9	180.6	11.79	1.152	0.523	1457
45	96.0	181.2	11.91	1.194	0.529	1421
46	DL	DL	DL	DL	DL	DL
47	DL	DL	DL	DL	DL	DL
Min Spec 100LL	84.4	182.7	13.23	1.126	0.461	1457

Min Spec = Minimum specification

3.9.2 PEAK EGT DATA.

Tables 30 through 37 show the peak EGT data for all power settings evaluated, the term MAE refers to the condition where maximum allowable EGT was reached prior to peak EGT, and further mixture leaning was aborted. DL refers to detonation limited in which detonation levels reached were severe enough to discontinue leaning.

Table 30. Peak EGT Data for Blends 1 Through 23, 2700 rpm

Blend	FF (lb/hr)	BHP	Air-to-Fuel Ratio	Equivalence Ratio	BSFC (lb/hp hr)	EGT (°F)
1	DL	DL	DL	DL	DL	DL
2	MAE	MAE	MAE	MAE	MAE	MAE
3	MAE	MAE	MAE	MAE	MAE	MAE
4	MAE	MAE	MAE	MAE	MAE	MAE
5	MAE	MAE	MAE	MAE	MAE	MAE
6	MAE	MAE	MAE	MAE	MAE	MAE
7	DL	DL	DL	DL	DL	DL
8	111.2	252.4	14.36	1.001	0.442	1628
9	MAE	MAE	MAE	MAE	MAE	MAE
10	MAE	MAE	MAE	MAE	MAE	MAE
11	DL	DL	DL	DL	DL	DL
12	DL	DL	DL	DL	DL	DL
13	DL	DL	DL	DL	DL	DL
14	MAE	MAE	MAE	MAE	MAE	MAE
15	MAE	MAE	MAE	MAE	MAE	MAE
16	DL	DL	DL	DL	DL	DL

Table 30. Peak EGT Data for Blends 1 Through 23, 2700 rpm (Continued)

Blend	FF (lb/hr)	BHP	Air-to-Fuel Ratio	Equivalence Ratio	BSFC (lb/hp hr)	EGT (°F)
17	MAE	MAE	MAE	MAE	MAE	MAE
18	DL	DL	DL	DL	DL	DL
19	DL	DL	DL	DL	DL	DL
20	MAE	MAE	MAE	MAE	MAE	MAE
21	MAE	MAE	MAE	MAE	MAE	MAE
22	DL	DL	DL	DL	DL	DL
23	MAE	MAE	MAE	MAE	MAE	MAE

Table 31. Peak EGT Data for Blends 24 Through 47 and Minimum Specification 100LL, 2700 rpm

Blend	FF (lb/hr)	BHP	Air-to-Fuel Ratio	Equivalence Ratio	BSFC (lb/hp hr)	EGT (°F)
24	MAE	MAE	MAE	MAE	MAE	MAE
25	DL	DL	DL	DL	DL	DL
26	MAE	MAE	MAE	MAE	MAE	MAE
27	MAE	MAE	MAE	MAE	MAE	MAE
28	MAE	MAE	MAE	MAE	MAE	MAE
29	DL	DL	DL	DL	DL	DL
30	DL	DL	DL	DL	DL	DL
31	MAE	MAE	MAE	MAE	MAE	MAE
32	DL	DL	DL	DL	DL	DL
33	DL	DL	DL	DL	DL	DL
34	DL	DL	DL	DL	DL	DL
35	118.3	265.7	13.88	1.043	0.452	1625
36	DL	DL	DL	DL	DL	DL
37	MAE	MAE	MAE	MAE	MAE	MAE
38	DL	DL	DL	DL	DL	DL
39	DL	DL	DL	DL	DL	DL
40	DL	DL	DL	DL	DL	DL
41	MAE	MAE	MAE	MAE	MAE	MAE
42	DL	DL	DL	DL	DL	DL
43	DL	DL	DL	DL	DL	DL
44	DL	DL	DL	DL	DL	DL
45	DL	DL	DL	DL	DL	DL
46	DL	DL	DL	DL	DL	DL
47	DL	DL	DL	DL	DL	DL
Min Spec 100LL	DL	DL	DL	DL	DL	DL

Min Spec = Minimum specification

Table 32. Peak EGT Data for Blends 1 Through 23, 2600 rpm

Blend	FF (lb/hr)	BHP	Air-to-Fuel Ratio	Equivalence Ratio	BSFC (lb/hp hr)	EGT (°F)
1	DL	DL	DL	DL	DL	DL
2	97.9	223.9	14.48	0.988	0.435	1599
3	103.6	224.3	13.30	1.012	0.462	1608
4	97.0	225.1	14.48	0.996	0.428	1595
5	99.2	223.8	14.09	1.003	0.444	1599
6	96.3	223.2	14.62	0.989	0.430	1598
7	95.6	220.9	14.64	0.986	0.432	1592
8	98.2	224.7	14.34	1.003	0.438	1594
9	DL	DL	DL	DL	DL	DL
10	101.3	223.6	13.65	1.009	0.453	1599
11	DL	DL	DL	DL	DL	DL
12	DL	DL	DL	DL	DL	DL
13	DL	DL	DL	DL	DL	DL
14	102.0	223.3	13.43	1.007	0.459	1607
15	99.4	225.8	14.04	1.010	0.440	1605
16	95.4	224.5	14.61	0.996	0.425	1601
17	98.5	222.7	13.96	1.004	0.442	1592
18	DL	DL	DL	DL	DL	DL
19	DL	DL	DL	DL	DL	DL
20	103.9	222.1	13.60	1.006	0.468	1598
21	100.5	221.9	13.88	0.990	0.454	1601
22	DL	DL	DL	DL	DL	DL
23	102.8	222.4	13.98	1.005	0.460	1594

Table 33. Peak EGT Data for Blends 24 Through 47 and Minimum Specification 100LL, 2600 rpm

Blend	FF (lb/hr)	BHP	Air-to-Fuel Ratio	Equivalence Ratio	BSFC (lb/hp hr)	EGT (°F)
24	100.0	222.2	13.92	0.998	0.446	1604
25	DL	DL	DL	DL	DL	DL
26	99.6	223.3	14.11	0.990	0.444	1607
27	96.2	226.4	14.48	1.004	0.425	1599
28	96.6	223.9	14.56	0.993	0.430	1605
29	DL	DL	DL	DL	DL	DL
30	DL	DL	DL	DL	DL	DL
31	96.9	223.9	14.21	1.003	0.432	1611
32	DL	DL	DL	DL	DL	DL
33	DL	DL	DL	DL	DL	DL
34	DL	DL	DL	DL	DL	DL
35	DL	DL	DL	DL	DL	DL
36	96.0	225.6	14.68	0.990	0.426	1598

Table 33. Peak EGT Data for Blends 24 Through 47 and Minimum Specification 100LL, 2600 rpm (Continued)

Blend	FF (lb/hr)	BHP	Air-to-Fuel Ratio	Equivalence Ratio	BSFC (lb/hp hr)	EGT (°F)
37	97.0	223.7	14.31	1.008	0.432	1600
38	DL	DL	DL	DL	DL	DL
39	DL	DL	DL	DL	DL	DL
40	DL	DL	DL	DL	DL	DL
41	DL	DL	DL	DL	DL	DL
42	DL	DL	DL	DL	DL	DL
43	DL	DL	DL	DL	DL	DL
44	DL	DL	DL	DL	DL	DL
45	DL	DL	DL	DL	DL	DL
46	DL	DL	DL	DL	DL	DL
47	DL	DL	DL	DL	DL	DL
Min Spec 100LL	DL	DL	DL	DL	DL	DL

Min Spec = Minimum specification

Table 34. Peak EGT Data for Blends 1 Through 23, 2450 rpm

Blend	FF (lb/hr)	BHP	Air-to-Fuel Ratio	Equivalence Ratio	BSFC (lb/hp hr)	EGT (°F)
1	DL	DL	DL	DL	DL	DL
2	86.2	197.7	14.35	0.997	0.436	1570
3	90.8	197.5	13.50	0.997	0.458	1573
4	85.8	199.0	14.48	0.997	0.430	1558
5	87.3	198.5	14.27	0.991	0.439	1566
6	86.0	200.7	14.35	1.008	0.428	1565
7	85.1	198.6	14.63	0.986	0.429	1557
8	86.9	198.8	14.52	0.990	0.436	1560
9	89.5	197.8	13.68	0.999	0.453	1564
10	88.7	196.0	13.86	0.995	0.451	1562
11	DL	DL	DL	DL	DL	DL
12	DL	DL	DL	DL	DL	DL
13	DL	DL	DL	DL	DL	DL
14	89.2	197.2	13.54	1	0.452	1571
15	87.5	200.3	14.10	1.006	0.436	1566
16	84.4	198.1	14.59	0.996	0.425	1561
17	87.9	199.4	13.98	1.002	0.440	1556
18	DL	DL	DL	DL	DL	DL
19	DL	DL	DL	DL	DL	DL
20	91.8	198.0	13.65	1.002	0.463	1562
21	89.5	197.5	13.79	0.997	0.452	1565
22	DL	DL	DL	DL	DL	DL
23	87.8	197.1	13.96	1.006	0.445	1555

Table 35. Peak EGT Data for Blends 24 Through 47 and Minimum Specification 100LL, 2450 rpm

Blend	FF (lb/hr)	BHP	Air-to-Fuel Ratio	Equivalence Ratio	BSFC (lb/hp hr)	EGT (°F)
24	88.5	198.7	13.8	1.007	0.444	1564
25	DL	DL	DL	DL	DL	DL
26	88.4	199.5	13.96	1.000	0.442	1566
27	84.8	201.0	14.54	1.000	0.423	1560
28	85.4	199.2	14.54	0.994	0.429	1566
29	DL	DL	DL	DL	DL	DL
30	DL	DL	DL	DL	DL	DL
31	85.8	198.4	14.27	0.999	0.430	1574
32	DL	DL	DL	DL	DL	DL
33	DL	DL	DL	DL	DL	DL
34	DL	DL	DL	DL	DL	DL
35	86.4	200.9	14.48	1.000	0.429	1571
36	84.0	198.5	14.78	0.984	0.421	1562
37	85.9	199.4	14.49	0.996	0.430	1563
38	DL	DL	DL	DL	DL	DL
39	DL	DL	DL	DL	DL	DL
40	DL	DL	DL	DL	DL	DL
41	89.5	201.0	13.91	1.005	0.443	1578
42	DL	DL	DL	DL	DL	DL
43	87.0	200.9	14.31	1.001	0.434	1564
44	DL	DL	DL	DL	DL	DL
45	DL	DL	DL	DL	DL	DL
46	DL	DL	DL	DL	DL	DL
47	DL	DL	DL	DL	DL	DL
Min Spec 100LL	DL	DL	DL	DL	DL	DL

Min Spec = Minimum specification

Table 36. Peak EGT Data for Blends 1 Through 23, 2350 rpm

Blend	FF (lb/hr)	BHP	Air-to-Fuel Ratio	Equivalence Ratio	BSFC (lb/hp hr)	EGT (°F)
1	DL	DL	DL	DL	DL	DL
2	75.8	171.8	14.43	0.991	0.441	1549
3	80.1	171.0	13.44	1.001	0.467	1555
4	75.9	173.5	14.56	0.991	0.438	1540
5	77.1	171.9	14.25	0.993	0.448	1548
6	75.5	172.3	14.54	0.995	0.436	1544
7	74.0	168.5	14.52	0.993	0.438	1540
8	75.3	170.1	14.62	0.984	0.443	1541
9	78.4	170.1	13.75	0.995	0.460	1544
10	78.4	169.2	13.91	0.990	0.461	1547

Table 36. Peak EGT Data for Blends 1 Through 23, 2350 rpm (Continued)

Blend	FF (lb/hr)	BHP	Air-to-Fuel Ratio	Equivalence Ratio	BSFC (lb/hp hr)	EGT (°F)
11	DL	DL	DL	DL	DL	DL
12	DL	DL	DL	DL	DL	DL
13	DL	DL	DL	DL	DL	DL
14	78.6	170.2	13.48	1.003	0.460	1555
15	76.0	171.2	14.23	0.997	0.443	1553
16	74.5	173.0	14.66	0.992	0.429	1547
17	77.8	173.2	13.96	1.004	0.447	1541
18	DL	DL	DL	DL	DL	DL
19	DL	DL	DL	DL	DL	DL
20	79.5	168.6	13.87	0.987	0.470	1548
21	78.3	170.4	13.72	1.001	0.459	1552
22	DL	DL	DL	DL	DL	DL
23	77.7	172.2	14.04	1.001	0.447	1543

Table 37. Peak EGT Data for Blends 24 Through 47 and Minimum Specification 100LL, 2350 rpm

Blend	FF (lb/hr)	BHP	Air-to-Fuel Ratio	Equivalence Ratio	BSFC (lb/hp hr)	EGT (°F)
24	77.0	169.6	13.91	0.999	0.451	1557
25	DL	DL	DL	DL	DL	DL
26	76.1	169.8	13.87	1.006	0.446	1554
27	73.7	171.4	14.62	0.994	0.428	1546
28	75.5	172.0	14.73	0.982	0.438	1555
29	DL	DL	DL	DL	DL	DL
30	DL	DL	DL	DL	DL	DL
31	75.1	171.2	14.41	0.989	0.439	1562
32	DL	DL	DL	DL	DL	DL
33	DL	DL	DL	DL	DL	DL
34	DL	DL	DL	DL	DL	DL
35	74.9	171.8	14.53	0.997	0.434	1559
36	73.8	172.2	14.62	0.995	0.429	1552
37	74.8	170.5	14.48	0.996	0.438	1552
38	DL	DL	DL	DL	DL	DL
39	DL	DL	DL	DL	DL	DL
40	DL	DL	DL	DL	DL	DL
41	76.7	171.5	14.14	0.988	0.449	1566
42	DL	DL	DL	DL	DL	DL
43	75.6	171.2	14.36	0.998	0.442	1553
44	79.2	170.7	13.80	0.984	0.463	1557
45	DL	DL	DL	DL	DL	DL
46	DL	DL	DL	DL	DL	DL
47	DL	DL	DL	DL	DL	DL
Min Spec 100LL	DL	DL	DL	DL	DL	DL

Min Spec = Minimum specification

3.9.3 BEST ECONOMY DATA.

Tables 38 through 40 were determined in relation to the peak EGT data by subtracting the best economy data from the peak EGT data. Best economy typically appears slightly lean of peak EGT.

Table 38. Best Economy Relative to Peak EGT, 2600 and 2700 rpm

Blend	rpm	FF (lb/hr)	BHP	Air-to-Fuel Ratio	Equivalence Ratio	BSFC (lb/hp hr)	EGT (°F)
2	2600	4.4	8.2	-0.5	0.034	0.003	12
3	2600	6.2	11.6	-0.66	0.048	0.003	10
4	2600	4.6	8.7	-0.47	0.031	0.002	12
5	2600	3.5	6.4	-0.4	0.027	0.003	7
6	2600	1.3	2.2	0	0	0.001	1
7	2600	2.3	4.2	-0.23	0.016	0.003	5
8	2700	5.7	11.7	-0.65	0.043	0.002	14
8	2600	3.5	7	-0.43	0.03	0.002	4
10	2600	3.3	5.8	-0.37	0.026	0.002	5
14	2600	5.1	9.9	-0.47	0.034	0.003	11
15	2600	4.5	8.2	-0.46	0.032	0.003	7
16	2600	4.1	8.3	-0.43	0.03	0.002	13
17	2600	4.6	9.2	-0.45	0.032	0.002	12
20	2600	4.4	9	-0.47	0.034	0.003	12
21	2600	5.7	11.5	-0.41	0.028	0.002	17
23	2600	6.1	12.1	-0.71	0.048	0.004	16
24	2600	4.6	9.5	-0.39	0.027	0.003	12
26	2600	4.9	9.9	-0.3	0.022	0.002	12
27	2600	7.4	14.9	-0.79	0.052	0.005	19
28	2600	3.8	6.6	-0.23	0.016	0.002	7
31	2600	2.6	4.9	-0.29	0.02	0.002	3
35	2700	0	0	0	0	0	0
36	2600	4.9	9.6	-0.36	0.023	0.005	11
37	2600	2.5	4.8	-0.31	0.021	0.001	3

Table 39. Best Economy Relative to Peak EGT, 2450 rpm

Blend	rpm	FF (lb/hr)	BHP	Air-to-Fuel Ratio	Equivalence Ratio	BSFC (lb/hp hr)	EGT (°F)
2	2450	3.5	7.5	-0.52	0.035	0.001	8
3	2450	4.4	9.1	-0.47	0.034	0.002	11
4	2450	5.6	14.6	-0.8	0.053	0.004	21
5	2450	4.2	8.8	-0.46	0.031	0.001	13
6	2450	3.3	6.9	-0.49	0.033	0.001	5
7	2450	1	1.6	-0.03	0.002	0.002	2
8	2450	2.1	4.5	-0.13	0.008	0.001	3

Table 39. Best Economy Relative to Peak EGT, 2450 rpm (Continued)

Blend	rpm	FF (lb/hr)	BHP	Air-to-Fuel Ratio	Equivalence Ratio	BSFC (lb/hp hr)	EGT (°F)
9	2450	2.1	4.4	-0.26	0.018	0.001	2
10	2450	3	5.9	-0.34	0.025	0.001	7
14	2450	2	3.9	-0.19	0.015	0.001	3
15	2450	4.7	9.3	-0.51	0.036	0.002	10
16	2450	3.5	6.7	-0.41	0.027	0.003	9
17	2450	5.1	10.4	-0.63	0.043	0.002	12
20	2450	4.4	8.9	-0.39	0.028	0.001	10
21	2450	3.4	7	-0.29	0.021	0.002	7
23	2450	5.8	12.4	-0.69	0.047	0.002	16
24	2450	4.7	8.9	-0.57	0.04	0.002	11
26	2450	5.3	10.5	-0.47	0.033	0.003	14
27	2450	4.2	8.7	-0.5	0.034	0.004	9
28	2450	2.5	4.8	-0.17	0.011	0.002	4
31	2450	3.4	6.7	-0.37	0.025	0.001	7
35	2450	5.4	11.9	-0.75	0.049	0.005	23
36	2450	2.3	4.5	-0.02	0.002	0.003	5
37	2450	3.5	7.1	-0.38	0.026	0.003	11
41	2450	5.1	10.5	-0.66	0.046	0.004	17
43	2450	5.6	12.1	-0.83	0.055	0.005	16

Table 40. Best Economy Relative to Peak EGT, 2350 rpm

Blend	rpm	FF (lb/hr)	BHP	Air-to-Fuel Ratio	Equivalence Ratio	BSFC (lb/hp hr)	EGT (°F)
2	2350	1.1	2.2	-0.19	0.013	0.001	2
3	2350	2.7	5.1	-0.28	0.02	0.003	3
4	2350	4.1	8.8	-0.46	0.03	0.004	7
5	2350	4	8.3	-0.43	0.029	0.001	9
6	2350	4.1	8.8	-0.56	0.037	0.001	13
7	2350	2.9	6.5	-0.57	0.036	0.001	9
8	2350	1.1	1.6	0	0.001	0.003	3
9	2350	1.9	3.7	-0.27	0.02	0.002	4
10	2350	1.8	3.3	-0.09	0.006	0.002	3
14	2350	2.7	5.4	-0.38	0.027	0.001	7
15	2350	3.5	7.3	-0.35	0.024	0.002	10
16	2350	1.8	3.6	-0.21	0.015	0.001	3
17	2350	1.4	2.8	-0.16	0.012	0.001	1
20	2350	0.8	1.5	0.08	-0.005	0.002	2
21	2350	3.1	5.8	-0.33	0.023	0.002	7
23	2350	2.6	5.3	-0.37	0.026	0.002	6
24	2350	3.3	6.2	-0.43	0.031	0.001	10
26	2350	0	0	0	0	0	0
27	2350	3.1	5.9	-0.4	0.026	0.002	6
28	2350	1	1.9	0.16	-0.01	0.003	1

Table 40. Best Economy Relative to Peak EGT, 2350 rpm (Continued)

Blend	rpm	FF (lb/hr)	BHP	Air-to-Fuel Ratio	Equivalence Ratio	BSFC (lb/hp hr)	EGT (°F)
31	2350	2.4	4.5	-0.08	0.006	0.003	6
35	2350	2.9	6.3	-0.44	0.03	0.002	14
36	2350	5.2	12	-0.78	0.051	0.003	19
37	2350	2.1	4.5	-0.29	0.019	0.001	4
41	2350	2.1	4.4	-0.21	0.014	0.002	8
43	2350	2.9	5.9	-0.41	0.028	0.004	8
44	2350	4.8	9	-0.43	0.029	0.004	17

3.10 BLEND RANKINGS.

This section contains rankings of the fuel blend performances as compared to the minimum specification 100LL for all five detonation-onset parameters tested. Tables 41 through 44 are separated and ranked in descending performance order (i.e., the best performers at the top of the table to the worst at the bottom). As previously mentioned, blends 15 and 21 did not detonate under any of the conditions tested. Again, these tests were not certification tests and the engine was operated beyond what would be required for a detonation certification test. The multiple-regression model required input on engine detonation that could only be obtained by stressing these fuels to detonation.

Table 41. Blend Detonation Performance Rankings Based on Detonation-Onset FF, Equivalence Ratio, and Air-to-Fuel Ratio

Sorted by MON		Sorted by FF		Sorted by Equivalence Ratio		Sorted by Air-to-Fuel Ratio	
Blend	MON (ASTM D 2700)	Blend	Average FF (lb/hr)	Blend	Equivalence Ratio	Blend	Air-to-Fuel Ratio
15	106.3	15	---	15	---	15	---
21	106.2	21	---	21	---	21	---
6	106.0	6	82.0	6	1.011	6	14.34
28	106.0	28	89.0	2	1.020	28	14.10
31	105.6	2	90.1	3	1.023	2	14.04
3	105.3	31	90.6	28	1.027	8	13.84
8	105.0	3	93.3	31	1.033	31	13.80
2	104.8	5	97.5	8	1.039	41	13.45
41	104.8	8	99.2	41	1.040	4	13.45
20	104.2	41	100.9	10	1.055	37	13.27
5	104.1	4	101.2	14	1.057	35	13.21
37	104.1	35	104.0	20	1.060	5	13.19
14	104.0	10	104.3	5	1.073	3	13.16
26	104.0	37	105.4	4	1.074	10	13.08
10	103.9	14	105.6	37	1.088	16	13.04
4	103.9	7	106.4	26	1.095	7	13.02

Table 41. Blend Detonation Performance Rankings Based on Detonation-Onset FF, Equivalence Ratio, and Air-to-Fuel Ratio (Continued)

Sorted by MON		Sorted by FF		Sorted by Equivalence Ratio		Sorted by Air-to-Fuel Rati	
Blend	MON (ASTM D 2700)	Blend	Average FF (lb/hr)	Blend	Equivalence Ratio	Blend	Air-to-Fuel Ratio
35	103.8	16	107.4	35	1.097	20	12.91
7	103.4	20	107.7	7	1.110	36	12.88
24	103.3	26	108.3	23	1.111	14	12.82
23	103.0	Min Spec 100LL	109.0	16	1.116	26	12.76
36	103.0	36	109.0	24	1.124	27	12.74
44	102.9	27	110.0	36	1.129	43	12.68
16	102.8	43	110.3	43	1.130	Min Spec 100LL	12.66
17	102.7	23	110.8	9	1.133	23	12.66
27	102.7	24	112.4	17	1.133	17	12.37
43	102.6	17	112.7	27	1.142	24	12.37
9	102.5	9	114.5	44	1.153	9	12.08
40	102.0	44	117.1	Min Spec 100LL	1.178	13	11.97
42	101.5	13	117.9	42	1.190	45	11.82
13	101.2	45	118.6	13	1.202	25	11.81
45	101.1	42	120.3	45	1.204	29	11.81
33	101.1	33	120.8	12	1.214	44	11.80
12	101.1	40	121.3	22	1.219	22	11.74
25	101.0	25	121.4	33	1.223	33	11.56
Min Spec 100LL	100.6	22	121.6	40	1.224	42	11.55
38	100.6	12	122.0	25	1.240	12	11.55
22	100.5	29	123.2	38	1.241	40	11.54
39	100.4	18	125.1	29	1.243	18	11.49
29	100.2	38	127.0	11	1.246	32	11.27
11	99.8	32	127.1	18	1.249	46	11.09
47	99.8	1	127.8	39	1.263	38	11.06
1	99.7	39	127.9	34	1.269	39	11.06
18	99.6	11	128.0	1	1.280	11	11.05
34	98.8	34	129.5	32	1.280	30	11.02
32	98.8	30	130.5	19	1.286	19	10.96
46	98.2	19	131.0	47	1.316	1	10.84
19	97.6	46	132.5	30	1.330	34	10.84
30	97.6	47	135.1	46	1.353	47	10.66

Min Spec = Minimum specification

Table 42. Blend Detonation Performance Rankings Based on Detonation-Onset BSFC and EGT

Sorted by BSFC		Sorted by EGT	
Blend	BSFC (lb/hp hr)	Blend	EGT (°F)
15	---	15	---
21	---	21	---
6	0.436	41	1578
28	0.437	3	1567
31	0.441	28	1563
2	0.444	31	1562
8	0.451	14	1558
4	0.454	2	1555
41	0.459	8	1551
35	0.463	6	1550
3	0.466	10	1548
37	0.467	20	1544
5	0.469	4	1531
10	0.472	35	1525
7	0.473	26	1522
16	0.473	37	1521
14	0.474	5	1519
Min Spec 100LL	0.478	16	1499
36	0.480	7	1498
26	0.481	24	1497
27	0.483	23	1496
20	0.485	43	1496
43	0.488	9	1494
23	0.491	44	1491
17	0.498	36	1488
24	0.502	17	1479
9	0.509	27	1478
44	0.519	Min Spec 100LL	1463
13	0.521	42	1461
45	0.526	45	1456
33	0.534	33	1437
42	0.536	13	1436
22	0.540	12	1434
25	0.540	40	1430
40	0.541	38	1428
12	0.543	22	1427
29	0.546	11	1418
18	0.559	34	1410

Table 42. Blend Detonation Performance Rankings Based on Detonation-Onset BSFC and EGT (Continued)

Sorted by BSFC		Sorted by EGT	
Blend	BSFC (lb/hp hr)	Blend	EGT (°F)
38	0.564	25	1408
32	0.564	18	1406
39	0.573	39	1403
11	0.574	29	1402
1	0.575	1	1401
34	0.581	32	1390
30	0.586	19	1381
19	0.589	47	1370
46	0.597	30	1362
47	0.607	46	1343

Min Spec = Minimum specification

4. SUMMARY AND CONCLUSIONS.

The Federal Aviation Administration (FAA) William J. Hughes Technical Center Propulsion and Fuels Systems Team Small-Engine Test Facility evaluated 47 unleaded fuel blends in a full-scale Lycoming IO540-K engine. The blends consisted of Aviation and super alkylate base and contained various amounts of potential high-octane unleaded components such as: Toluene, Ethyl-tert-butyl-ether (ETBE), tert-Butylbenzene, and meta-Toluidine. All the blends contained 5% by volume Isopentane for volatility control. These blends were produced with a target range of 97.6 to 106.3 motor octane number (MON) and were not evaluated against the full aviation gasoline ASTM D 910 specification. As such, most of these blends would not meet the current aviation gasoline specification.

Test results show tight control of the engine temperature and environmental input conditions and the test repeatability was greater than 98.6% across all the detonation-onset parameters.

Tests were performed at conditions that probably would have been outside of those required for an engine certification test. This was done to provide data to a multiple-regression model for unleaded compositional analyses versus MON and engine full-scale detonation performance.

The engine detonation performances of these blends were compared against their MON and the engine detonation performance of a specially blended 100 low-lead aviation gasoline (100LL). The 100LL was blended to meet the minimum MON as per ASTM D 2700, and the minimum supercharge performance number (PN) as per ASTM D 909 of the current leaded aviation gasoline specification ASTM D 910. The minimum specification 100LL had a MON of 100.6, a PN of 130.9, and contained 1.55 ml tetra-ethyl lead (TEL) per gallon (gal.). Also evaluated was a 100LL purchased from the local airport, which had a 103.6 MON and a 133.0 PN and contained 1.70 ml TEL/gal.

The blends' detonation performances were ranked using the detonation-limited fuel mass flow rate (FF), brake-specific fuel consumption (BSFC), the equivalence ratio, the air-to-fuel ratio, and the average exhaust gas temperature (EGT). The best correlation of the MON to the engine performance was found with the equivalence ratio, EGT, BSFC, FF, and then, the air-to-fuel ratio. The relative rankings of the blends and their performance comparison showed slight variation with the comparator used for the detonation onset.

The blends' detonation performance in the full-scale engine correlated with the blends' MON with typical linear correlation coefficients ranging from 0.87 to 0.94 (r^2-values), depending on power setting and comparator. Blends 15 and 21, both with MONs above 106, did not detonate at any of the mixture and power setting combinations.

Using the detonation-onset FF as a comparator, 19 of the 47 unleaded blends performed better than the minimum specification 100LL when averaged over all the power settings. All the blends that performed better than the minimum specification 100LL had higher MONs than the 100LL. Fourteen unleaded blends that had higher MON values than the 100LL performed worse than the 100LL. The increase in MON required for the unleaded blends to perform equivalent to the minimum specification 100LL was found to range between 1.1 and 3.2 MON depending on the detonation-onset methods used. The average required increase in MON was 2.0.

As expected, the 100LL purchased from the local airport performed significantly better than the minimum specification 100LL.

While these tests addressed MON only, eventually the full spectrum of aviation gasoline specifications for 100LL, as listed in ASTM D 910, will have to be addressed.

The following conclusions have been drawn from the results of this study.

- The performance of unleaded fuel blends tested can differ significantly from the performance of leaded aviation gasoline components currently used in general aviation. This was shown when comparing the detonation performance of a leaded fuel to an unleaded blend having the same MON.

- Using only the MON, based on ASTM D 2700, of unleaded fuels to predict full-scale engine detonation performance is inadequate. The full-scale engine detonation performance of the unleaded fuel blends can deviate significantly from the performance suggested by their MON.

- For an unleaded fuel to provide full-scale engine detonation performance equal to a leaded aviation gasoline, the unleaded fuel will need a higher MON than the leaded aviation gasoline.

The blends' composition was compared against the MON and the detonation performance and the meta-Toluidine was shown to be the dominant component. The MON showed strong correlation to the meta-Toluidine composition ($r^2 = 0.82$). The first-order, linear detonation-

onset performance correlation (r^2) to the meta-Toluidine composition was also very high, ranging from 0.80 to 0.90, depending on the detonation-onset parameter used.

Equivalent detonation performance to the minimum specification 100LL was found to be accomplished with the addition of between 6% and 9.5% meta-Toluidine by volume depending on the detonation-onset comparator. None of the blends with less than 6% by volume performed as well as the minimum specification 100LL. All of the blends, except for two (blends 42 and 13), that contained greater than 6% by volume meta-Toluidine had MONs of 102.5 or greater.

As a continuation of the compositional analyses of this work, the FAA William J. Hughes Technical Center's engine data was supplied to the Unleaded Aviation Gasolines Development working group under the Aviation Gasolines Committee of the Coordinating Research Council for advanced statistical analyses. The analyses will be used to develop a multiple-regression model for these unleaded fuel components. This model will determine individual and synergistic contributions of the components to both the MON and the full-scale engine detonation performance.

APPENDIX A—PROPERTIES OF BLEND COMPONENTS

Table A-1. Blend Component Physical Properties

ASTM Test	Test Description	Aviation Alkylate	Super Alkylate	Toluene	tert-Butylbenzene	meta-Toluedine	ETBE	Isopentane
D 4052	Density, 15.56°C	0.6928	0.6994	0.8709	0.8701	0.9925	0.745	0.6243
D 4052	API gravity, °	72.5	70.5	30.8	31.0	10.9	58.2	19.7
D 5191	Vapor pressure, DVPE, psi	5.37	1.78	0.79	<0.1		4.14	<0.1
D 2700	Motor octane number	91.4	99.9					
D 5452	Sulfur content, mass %	0.0002	<0.0001	<0.0001	<0.0001		0.0002	<0.0001
E 1064	Water content, mass %						0.012	
D 2360	Toluene content, mass %			99.82			0.37	
D 541*	ETBE content, mass %						96.35	
	Metanol content, mass %						0.01	
	Ethanol contant, mass %						0.09	
D 850	Distallation range, °C			0.7	0.5			
	50% recovered, °C			110.6	169.0			
D 86	Distallation, % evaporated, °C							
	IBP	38.5	95.5					
	5	64.0	98.0					
	10	75.5	98.0					
	20	87.0	98.5					
	30	92.0	99.0					
	40	95.5	99.5					
	50	98.0	100.0			203-4 (lit.)		28.0 (lit.)
	60	100.5	100.5					
	70	103.5	101.5					
	80	106.0	103.0					
	90	111.5	110.5					
	95	122.0	164.0					
	Recovery	144.0	187.0					
	Residue	98.5	99.0					
	Loss	0.9	0.7					
		0.6	0.3					

*ETBE analyses conducted by test method ASTM D 5441 (MTBE gas chromatography method) but calibrated for impurities typical of ETBE.

API = American Petroleum Institute
DVPE = Dry vapor pressure equivalent
ETBE = Ethyl-tert-butyl-ether
IBP = Initial boiling point
lit. = liters

Table A-2. Super Alkylate Composition

	Mass %	Volume %
Isooctane	92.60	93.57
Isododecane	7.40	7.43

APPENDIX B—LYCOMING IO540-K DETONATION DATA

B.1 MIXTURE LEANOUTS.

All the graphs in this section represent mixture lean-outs on the different blends at different power settings. These do not represent all the test points reviewed, as the blends were tested between 3 and 5 times each, at each respective power setting. Furthermore, the dotted cursor does not necessarily represent a point of interest, but merely denotes the location of the cursor at the time the screen capture was taken. The data contained in the body of this report are from the average of the repeated tests, based on the degree of repeatability; the following graphs are some of the individual test runs. Not all of the data, nor all of the test runs, have been represented in graphical form in this appendix due to the enormous volume of data generated from this test. Furthermore, the data from the tests of the amine number blends were not included. The amine composition of these blends could not be determined due to the use of the wrong sample container material.

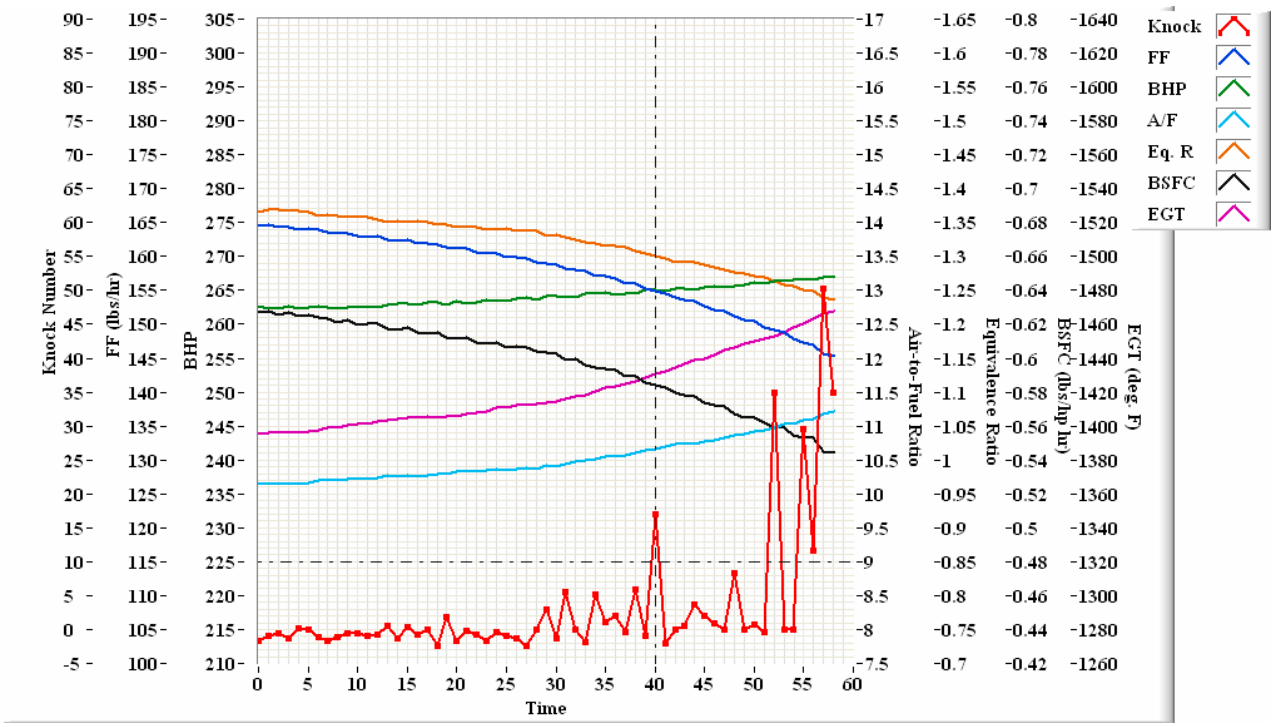


Figure B-1. Blend 1, 2700 rpm

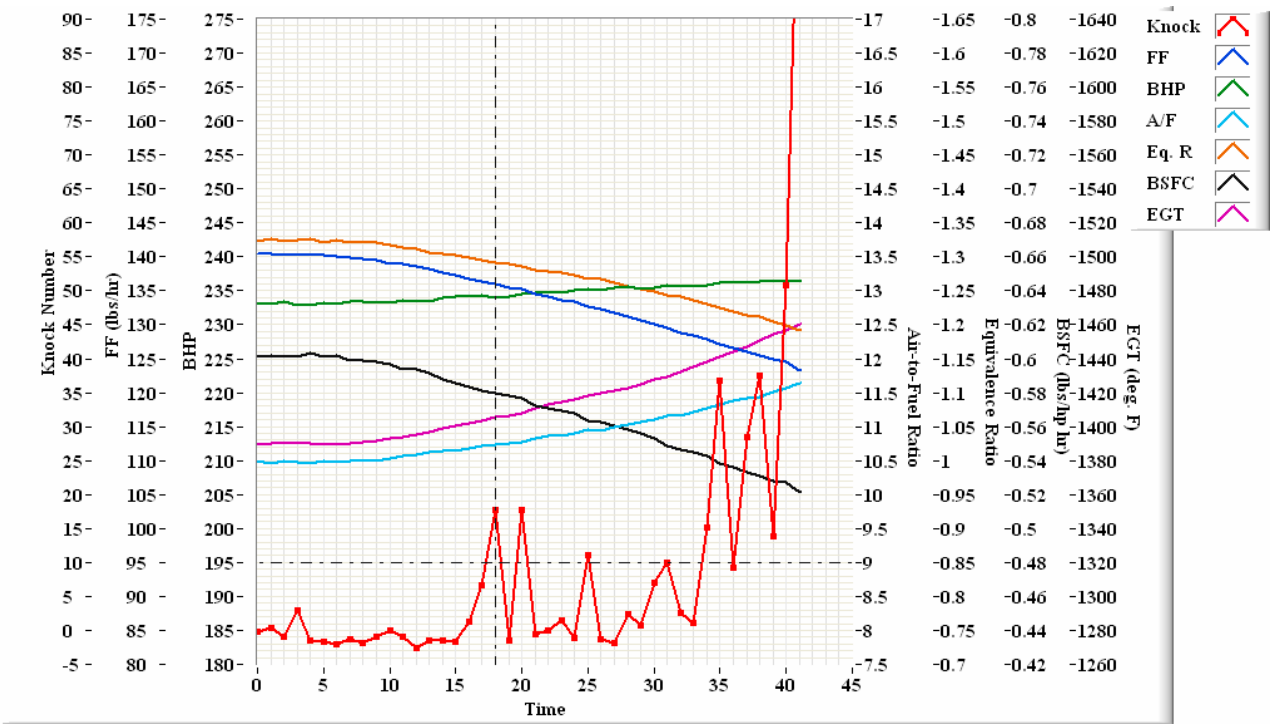


Figure B-2. Blend 1, 2600 rpm

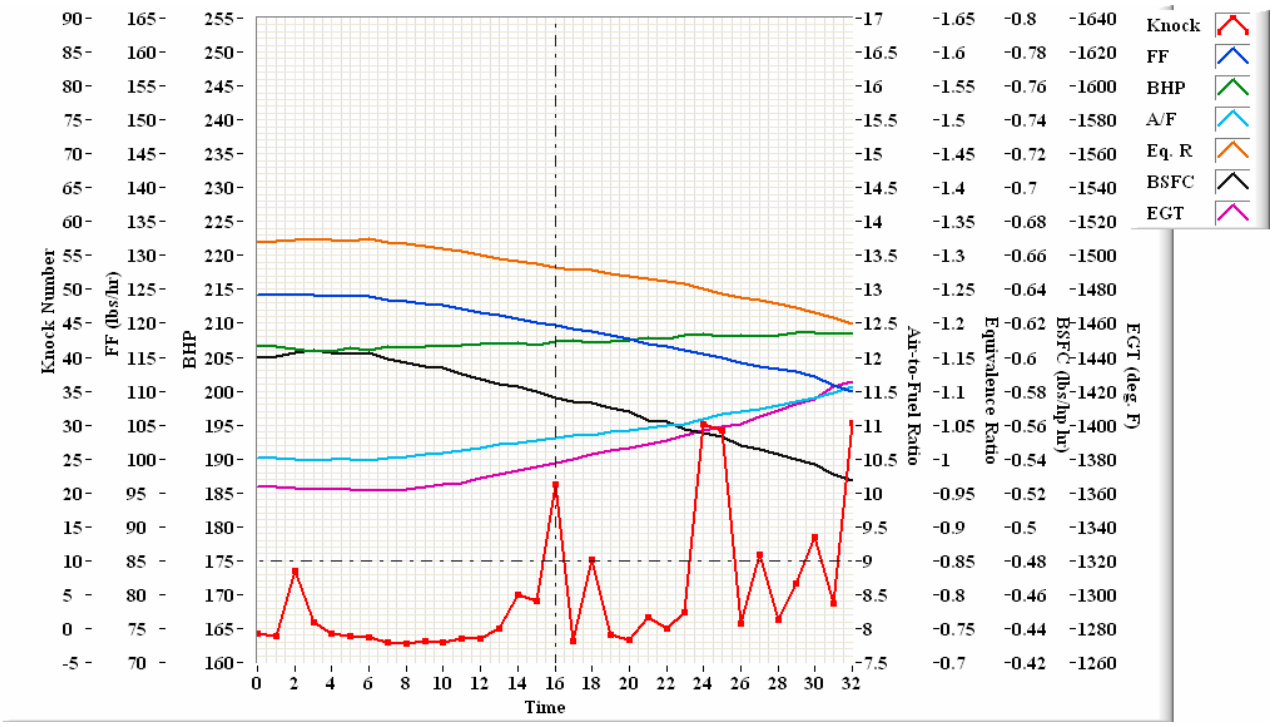


Figure B-3. Blend 1, 2450 rpm

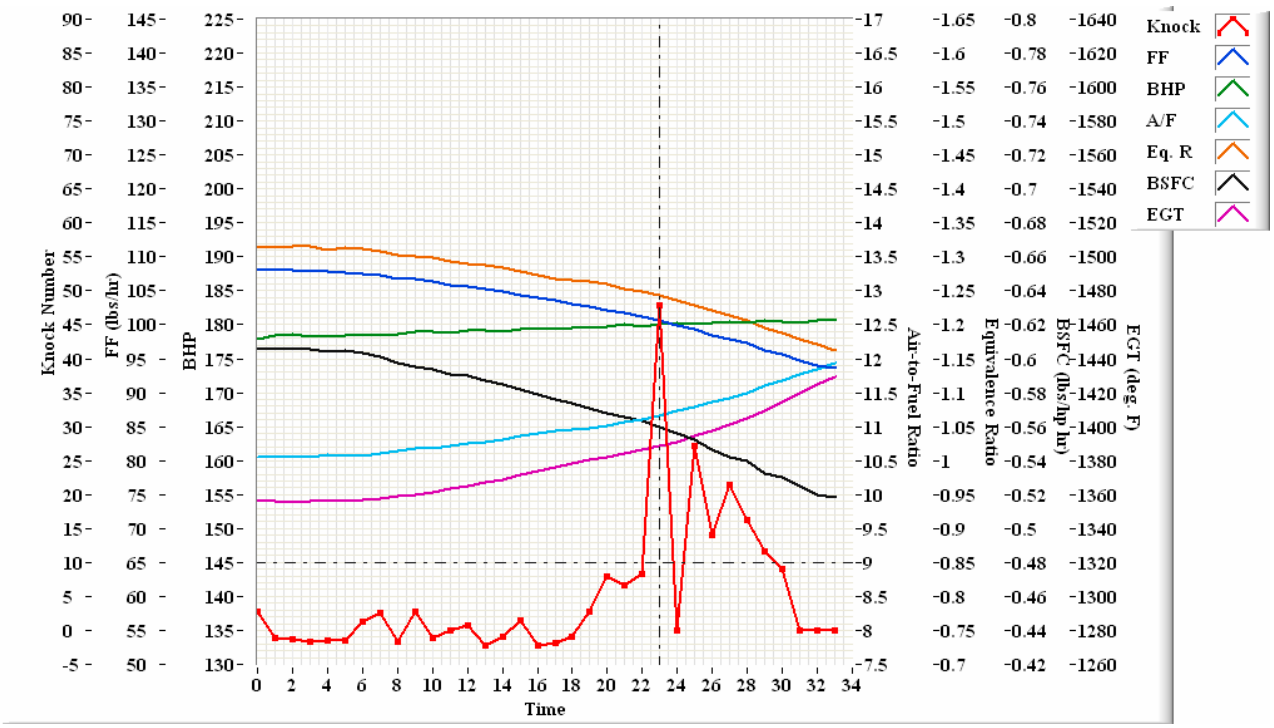


Figure B-4. Blend 1, 2350 rpm

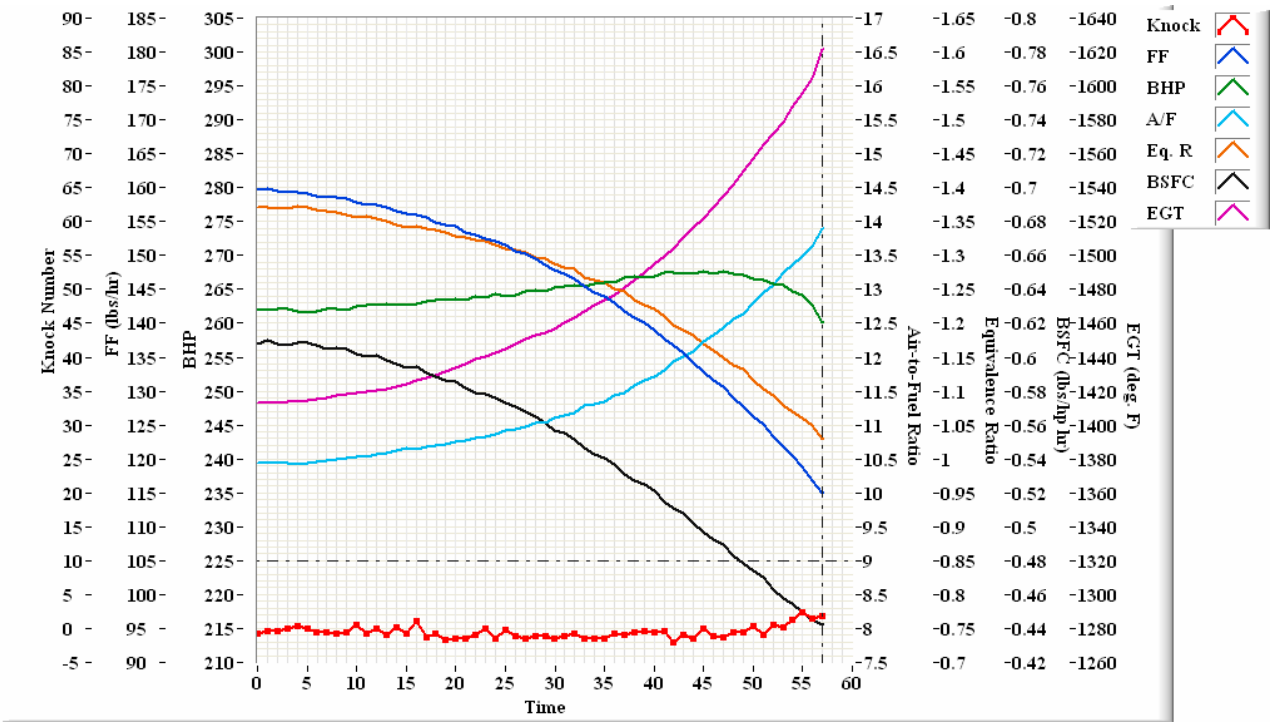


Figure B-5. Blend 2, 2700 rpm

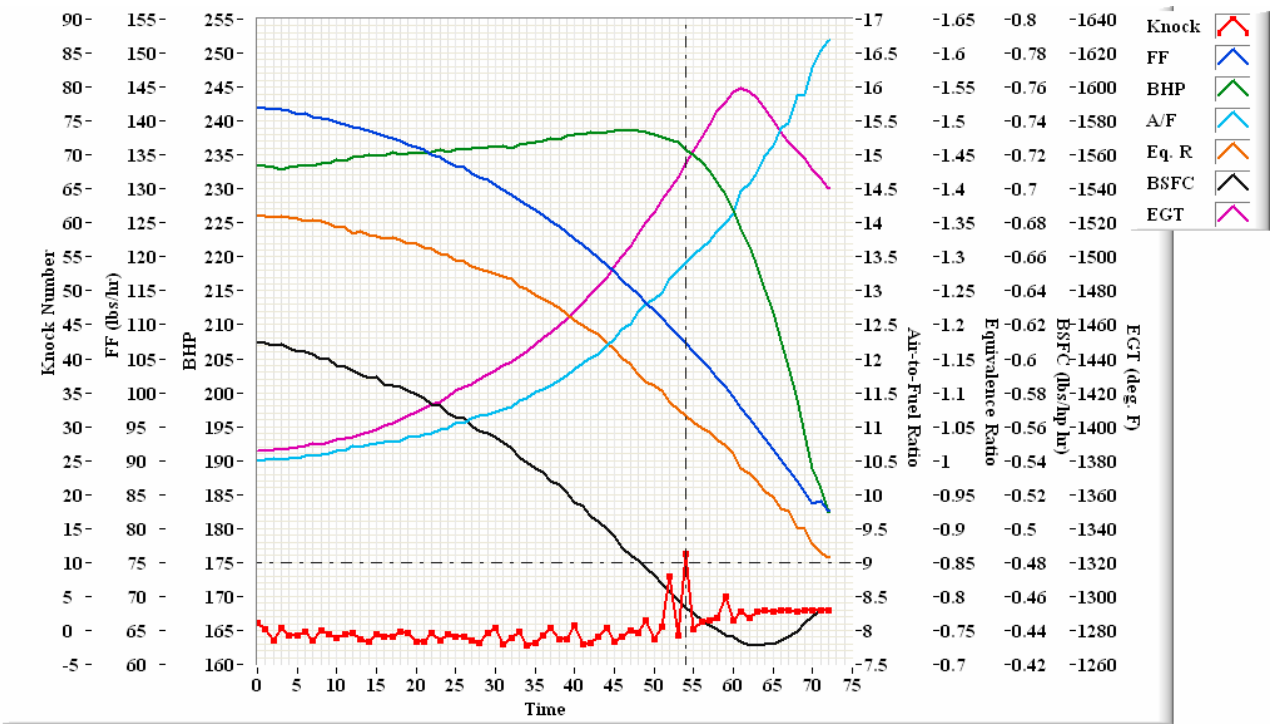


Figure B-6. Blend 2, 2600 rpm

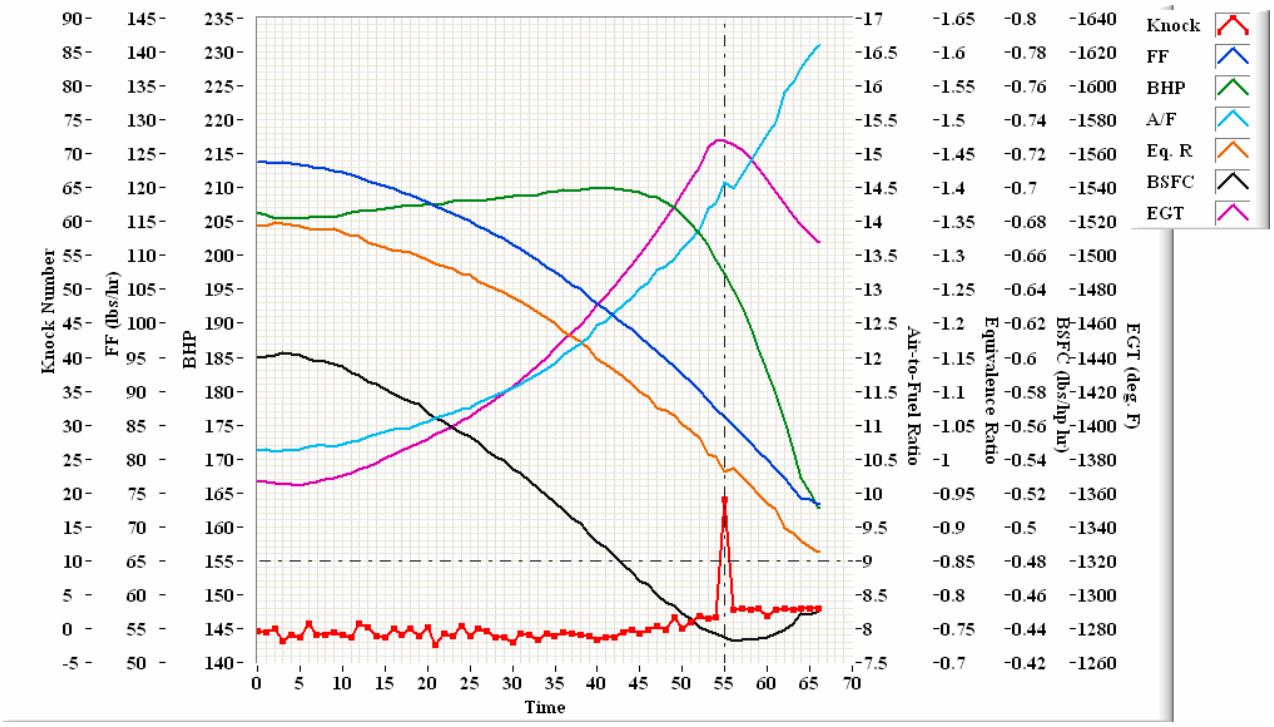


Figure B-7. Blend 2, 2450 rpm

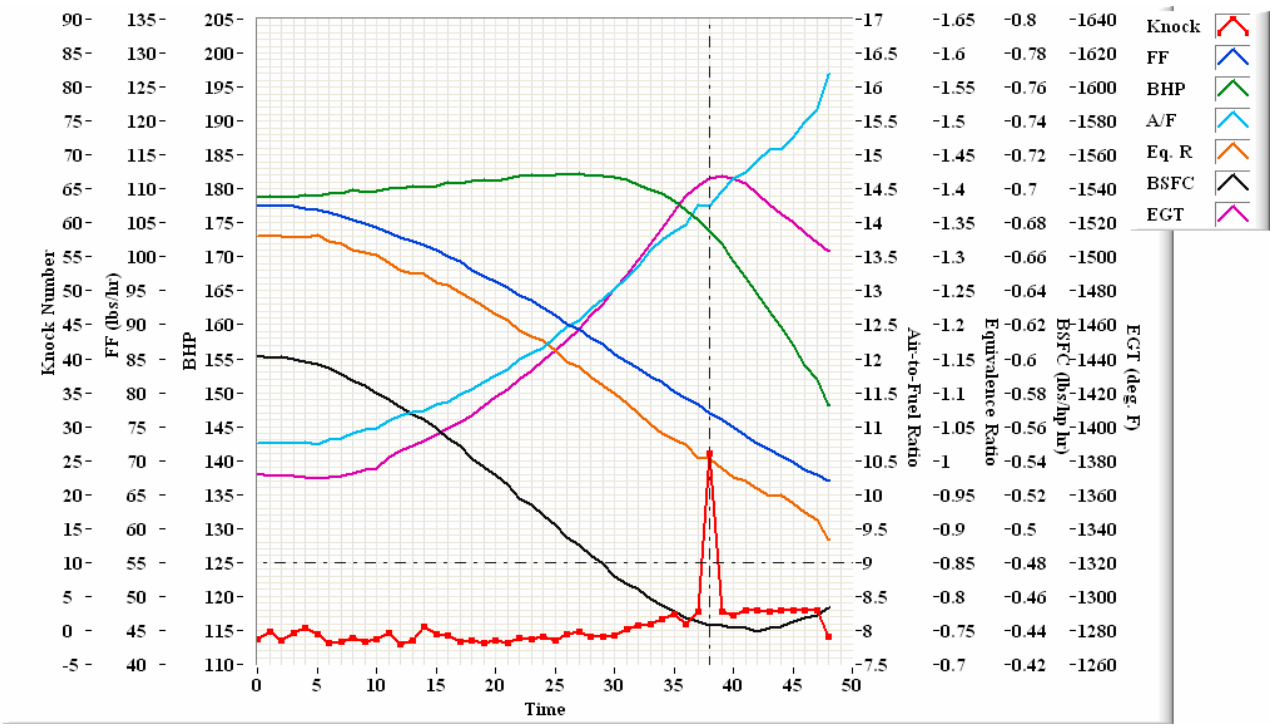


Figure B-8. Blend 2, 2350 rpm

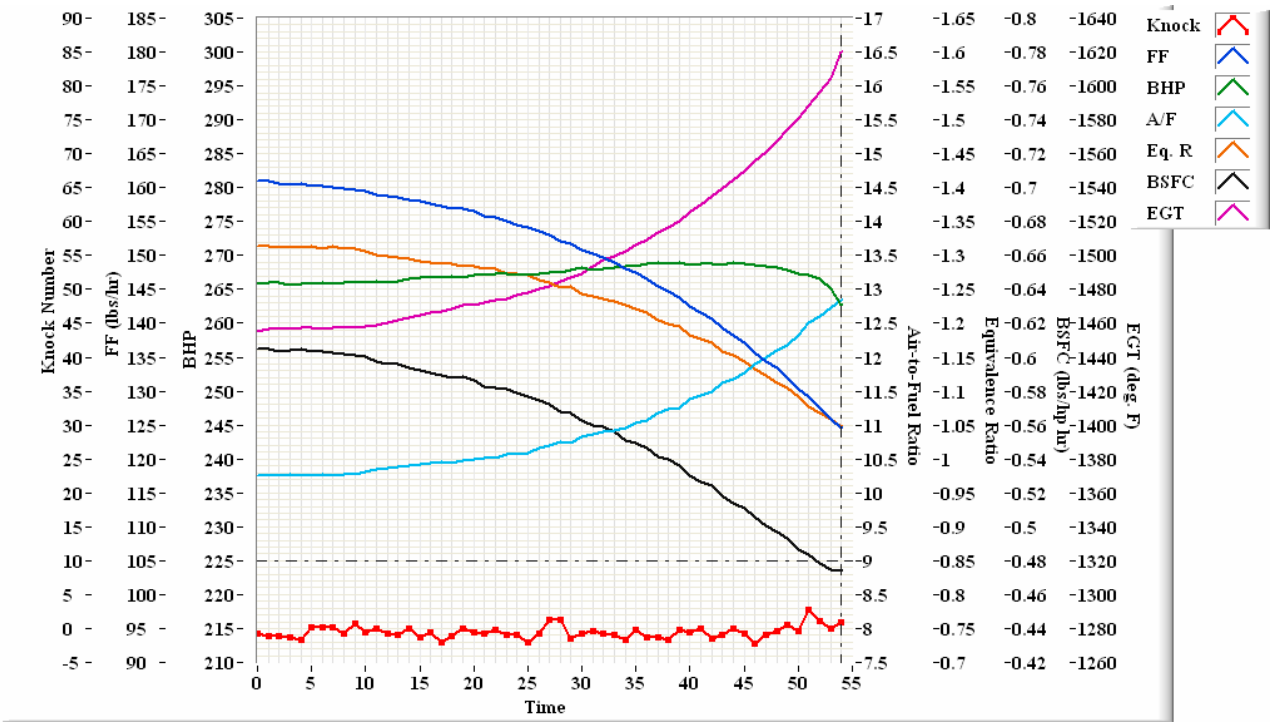


Figure B-9. Blend 3, 2700 rpm

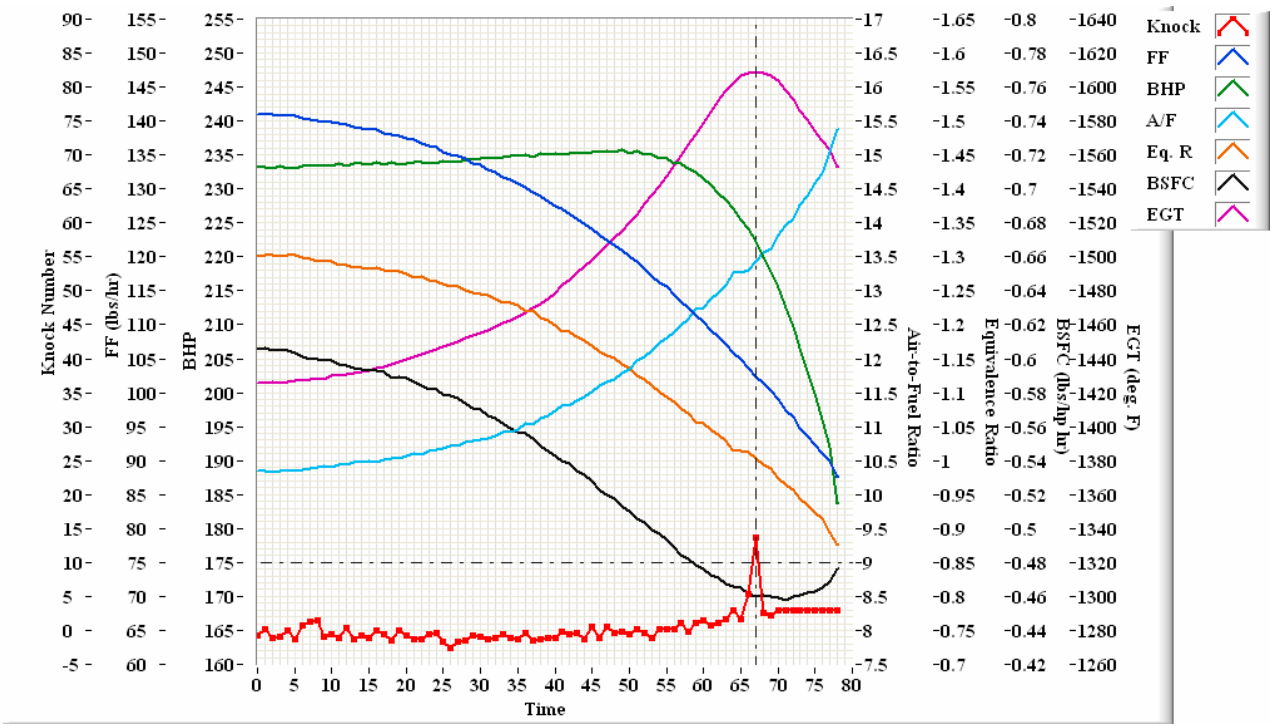


Figure B-10. Blend 3, 2600 rpm

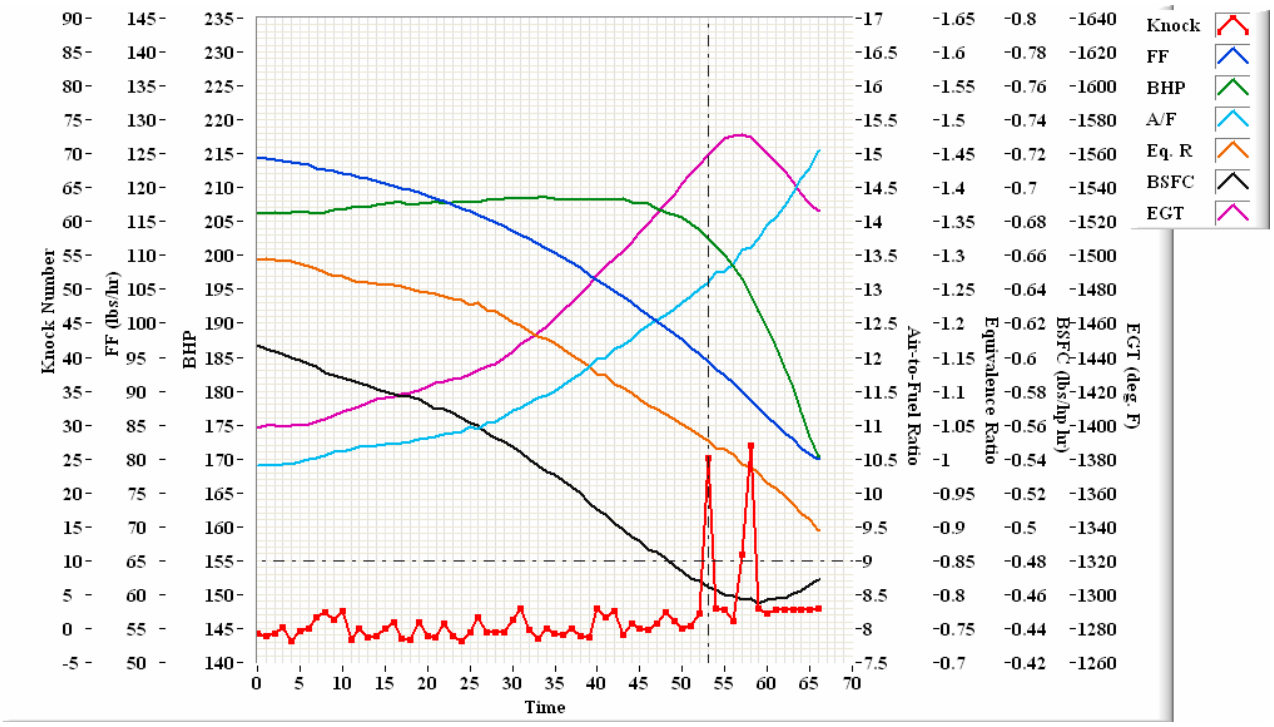


Figure B-11. Blend 3, 2450 rpm

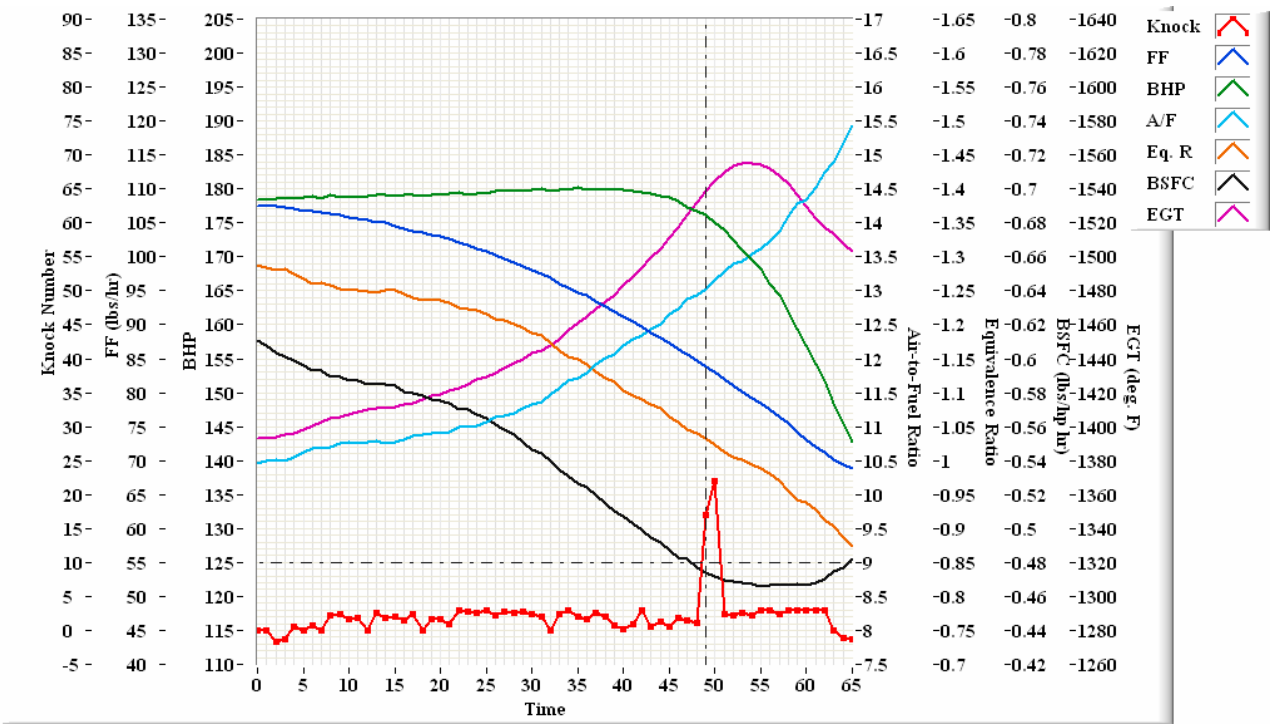


Figure B-12. Blend 3, 2350 rpm

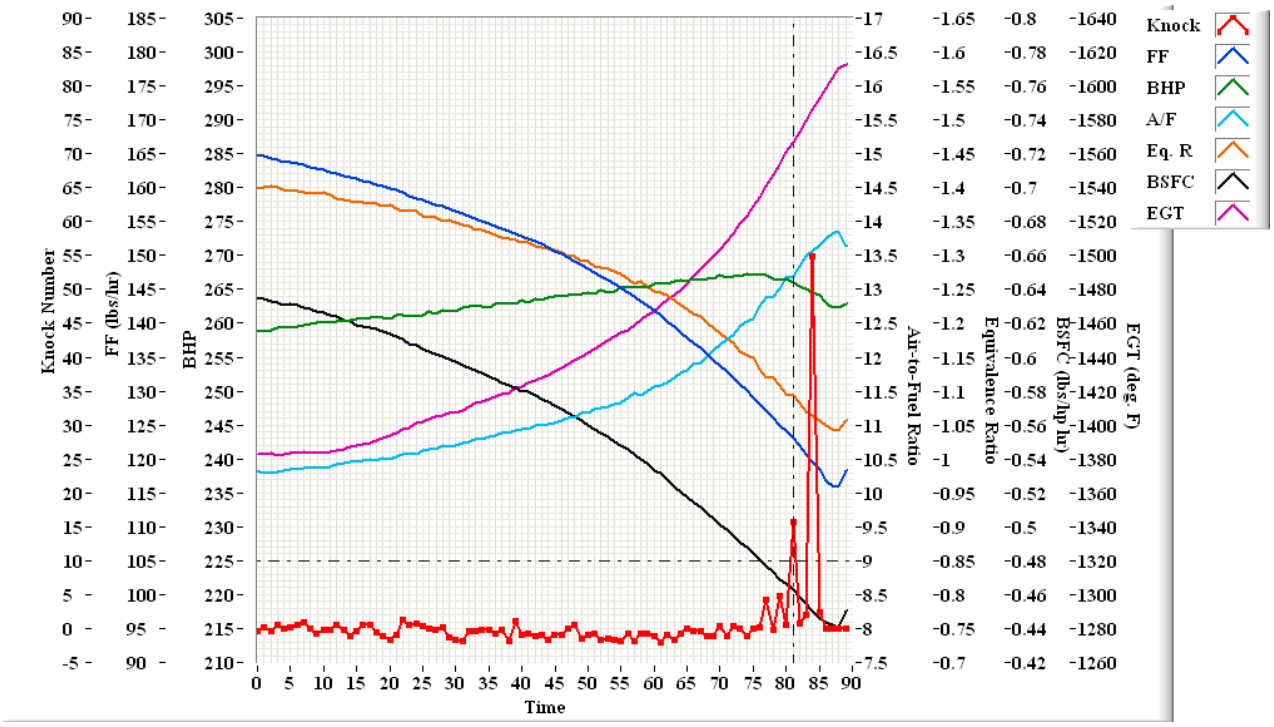


Figure B-13. Blend 4, 2700 rpm

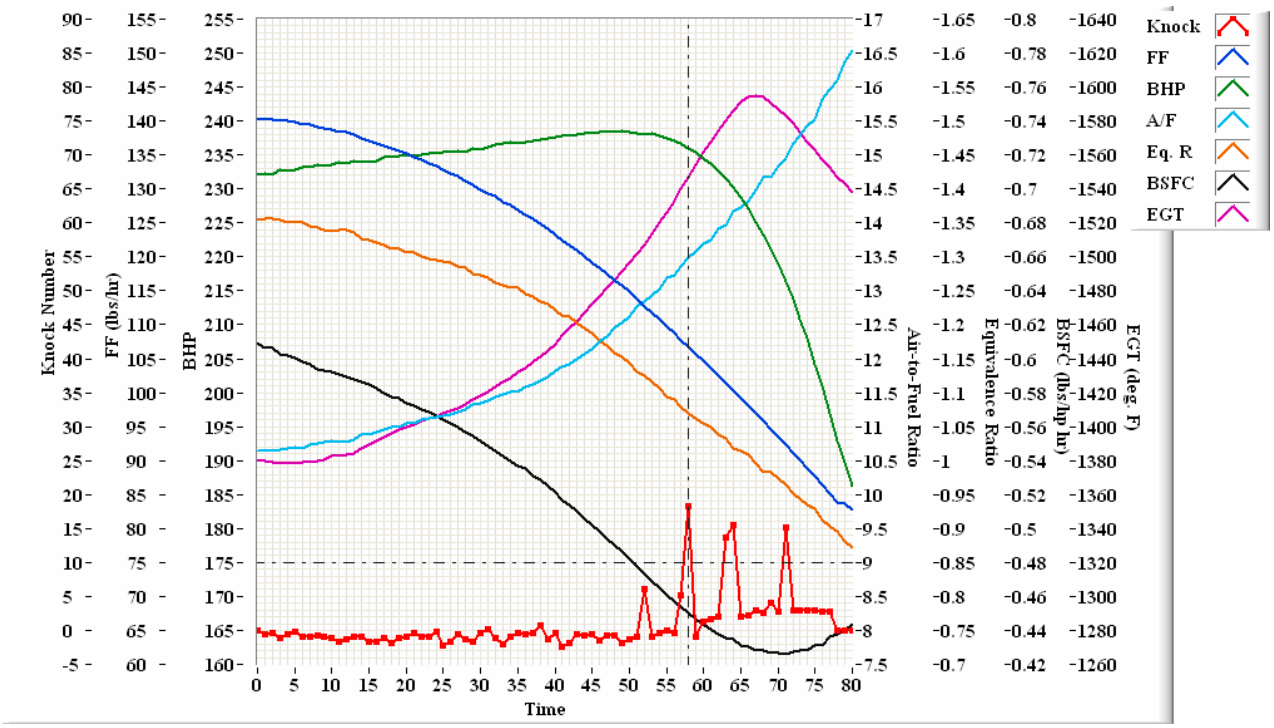


Figure B-14. Blend 4, 2600 rpm

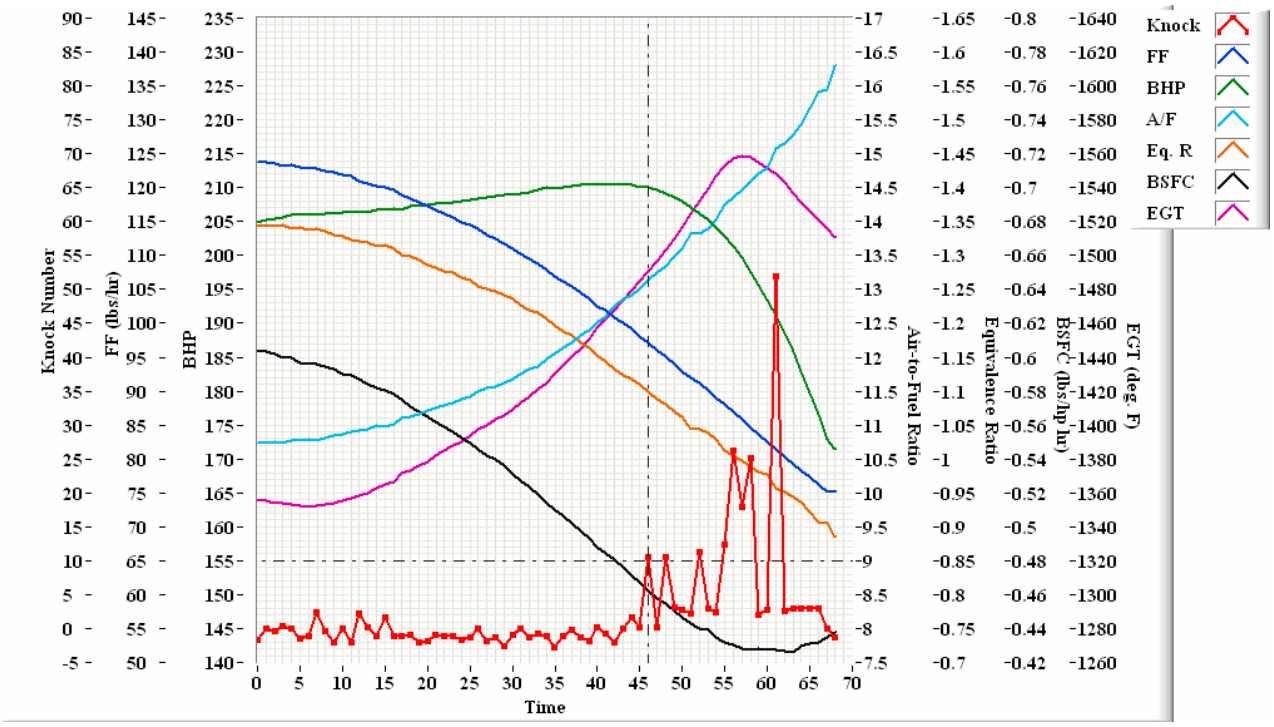


Figure B-15. Blend 4, 2450 rpm

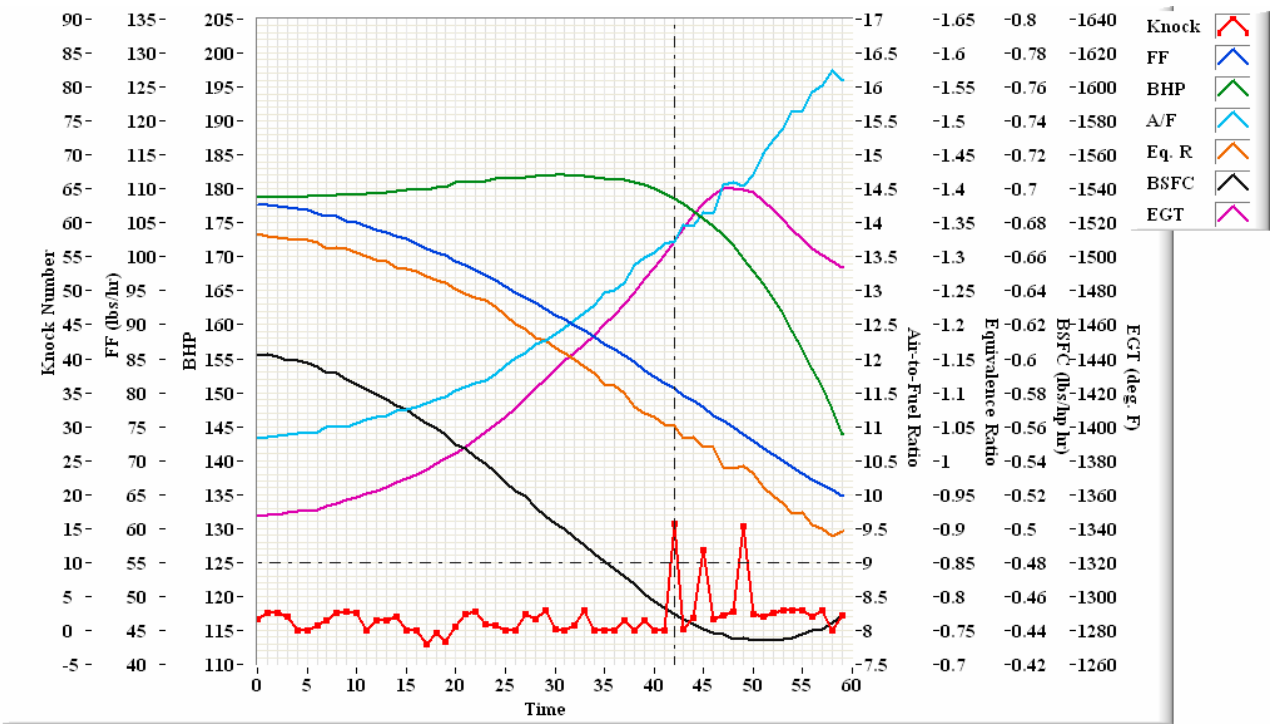


Figure B-16. Blend 4, 2350 rpm

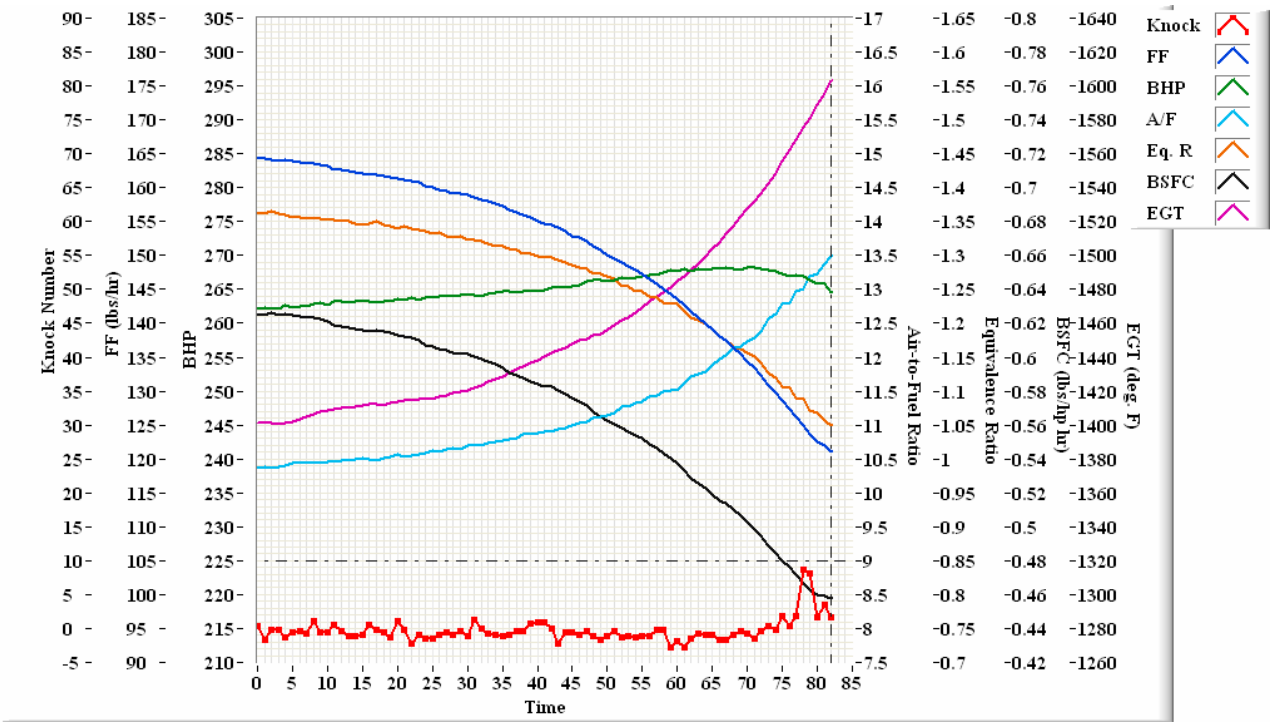


Figure B-17. Blend 5, 2700 rpm

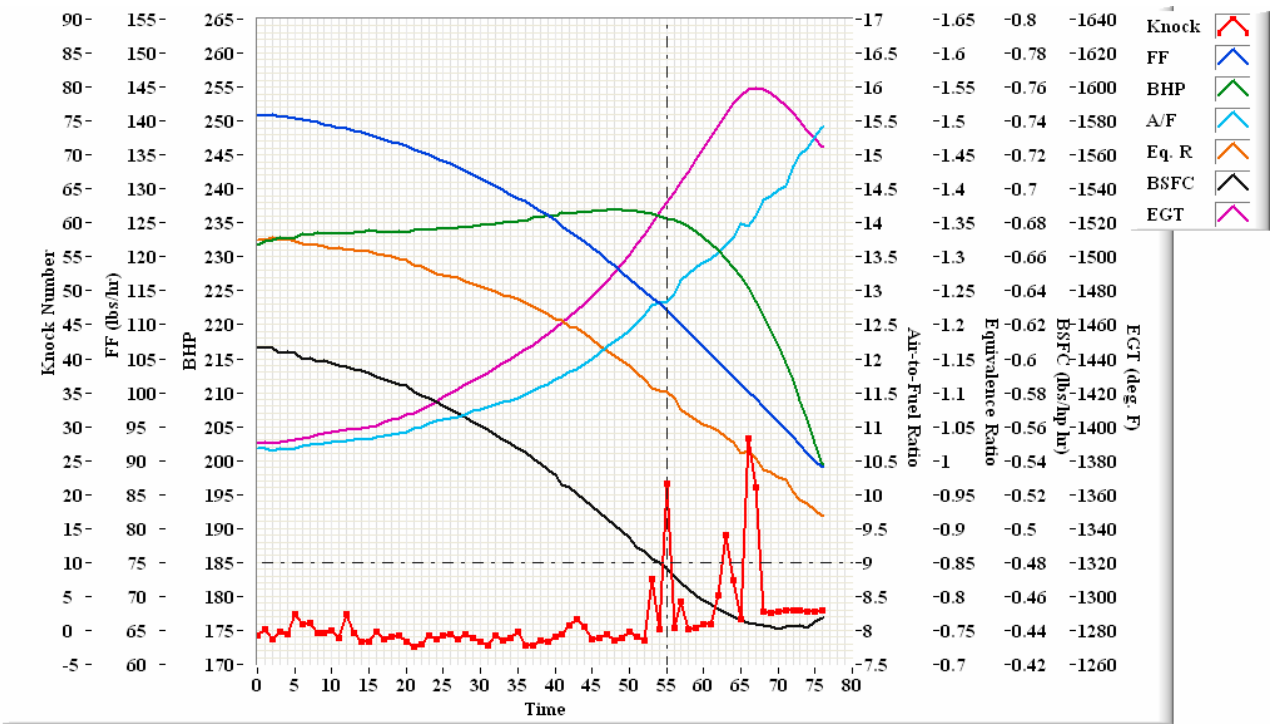


Figure B-18. Blend 5, 2600 rpm

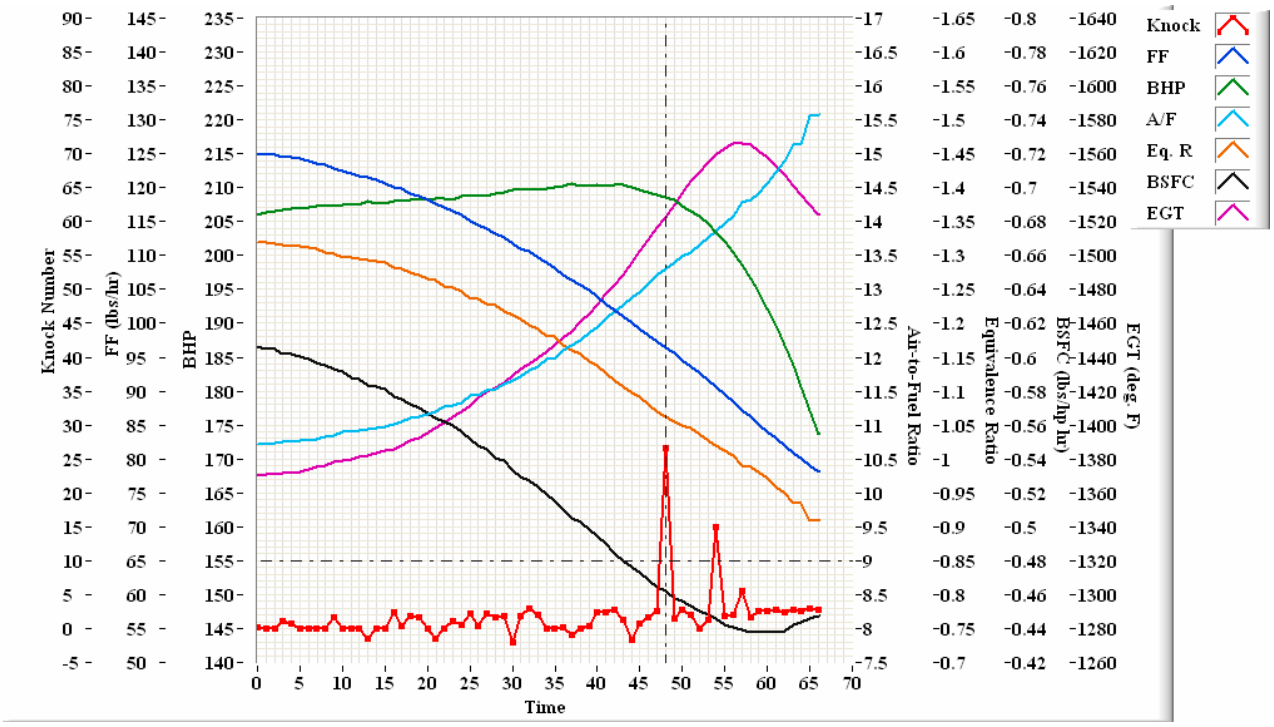


Figure B-19. Blend 5, 2450 rpm

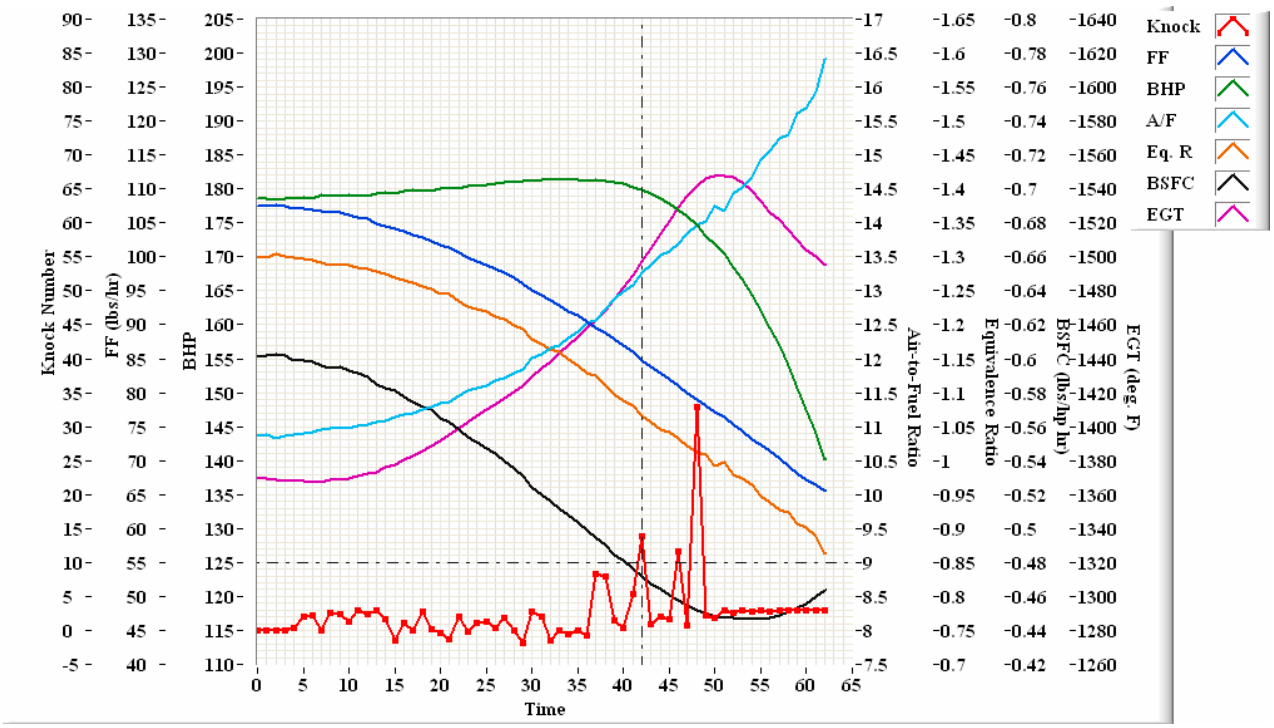


Figure B-20. Blend 5, 2350 rpm

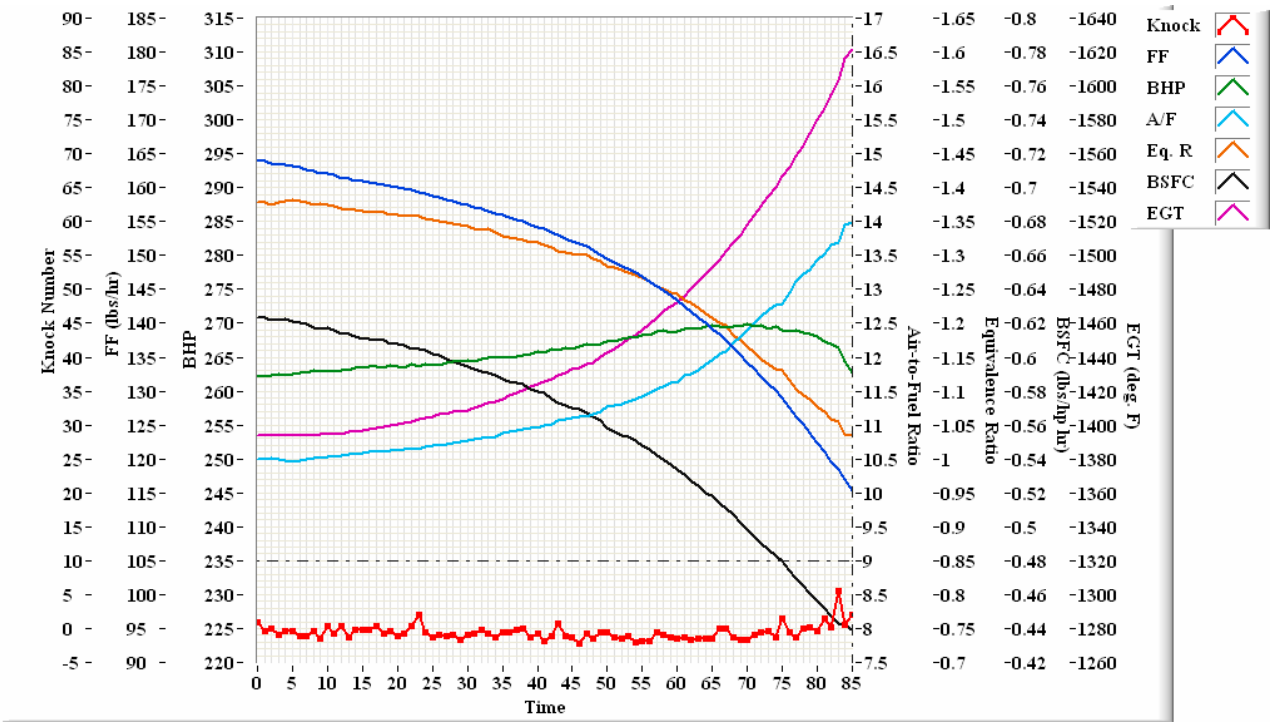


Figure B-21. Blend 6, 2700 rpm

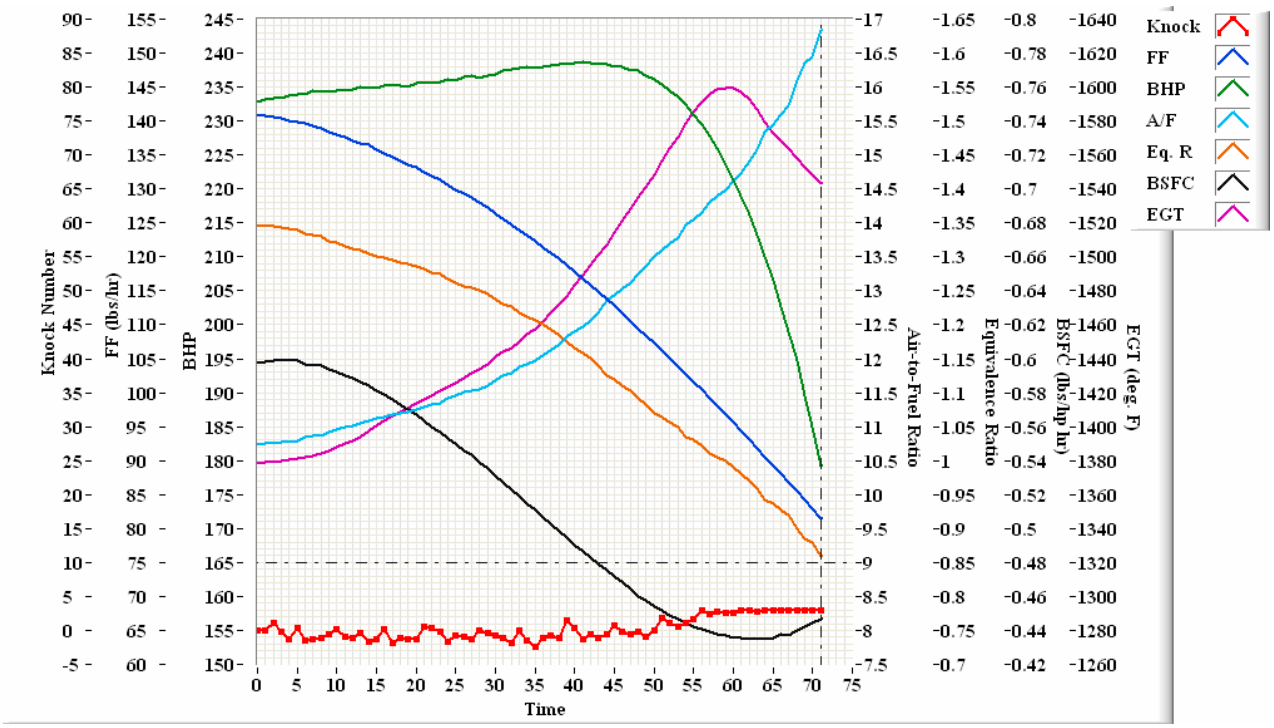


Figure B-22. Blend 6, 2600 rpm

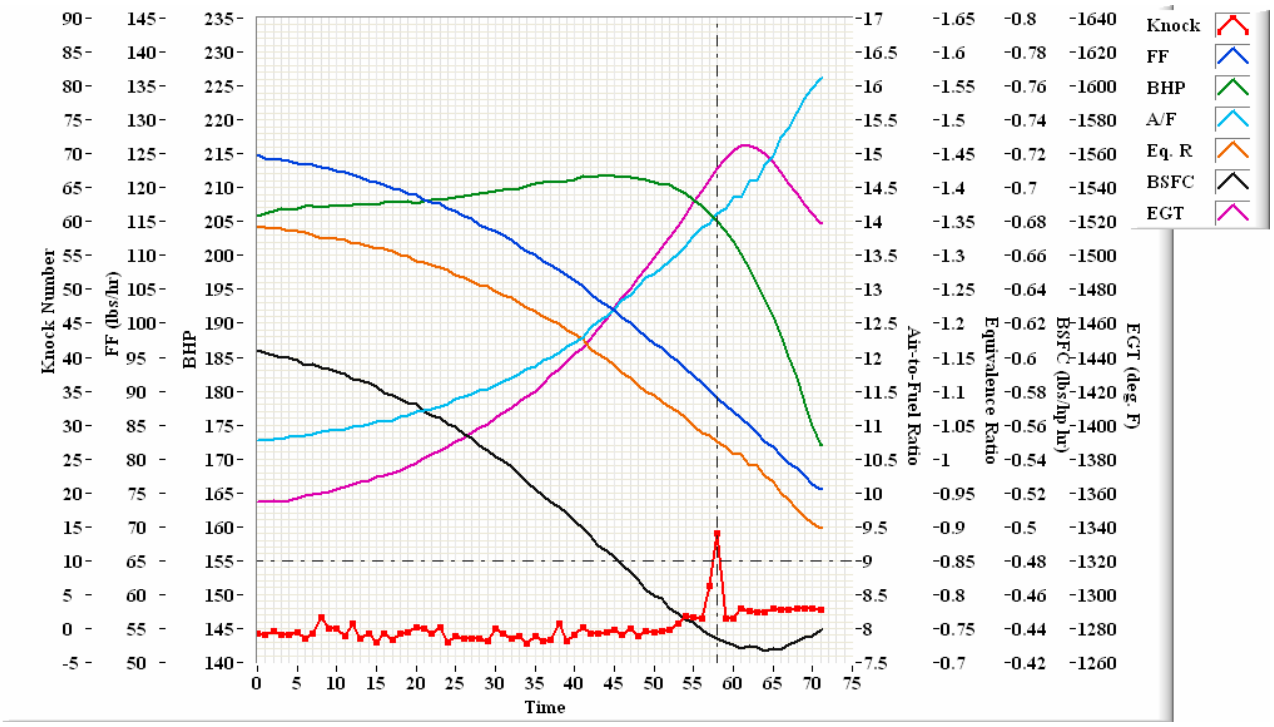


Figure B-23. Blend 6, 2450 rpm

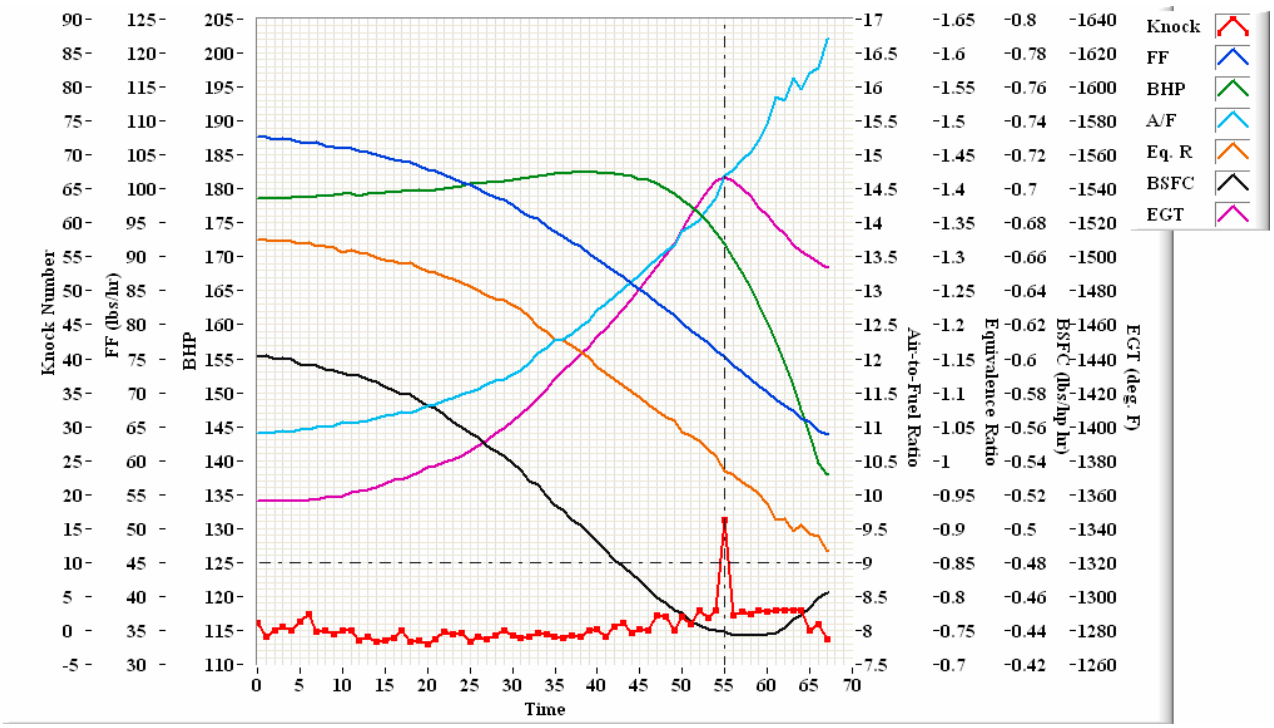


Figure B-24. Blend 6, 2350 rpm

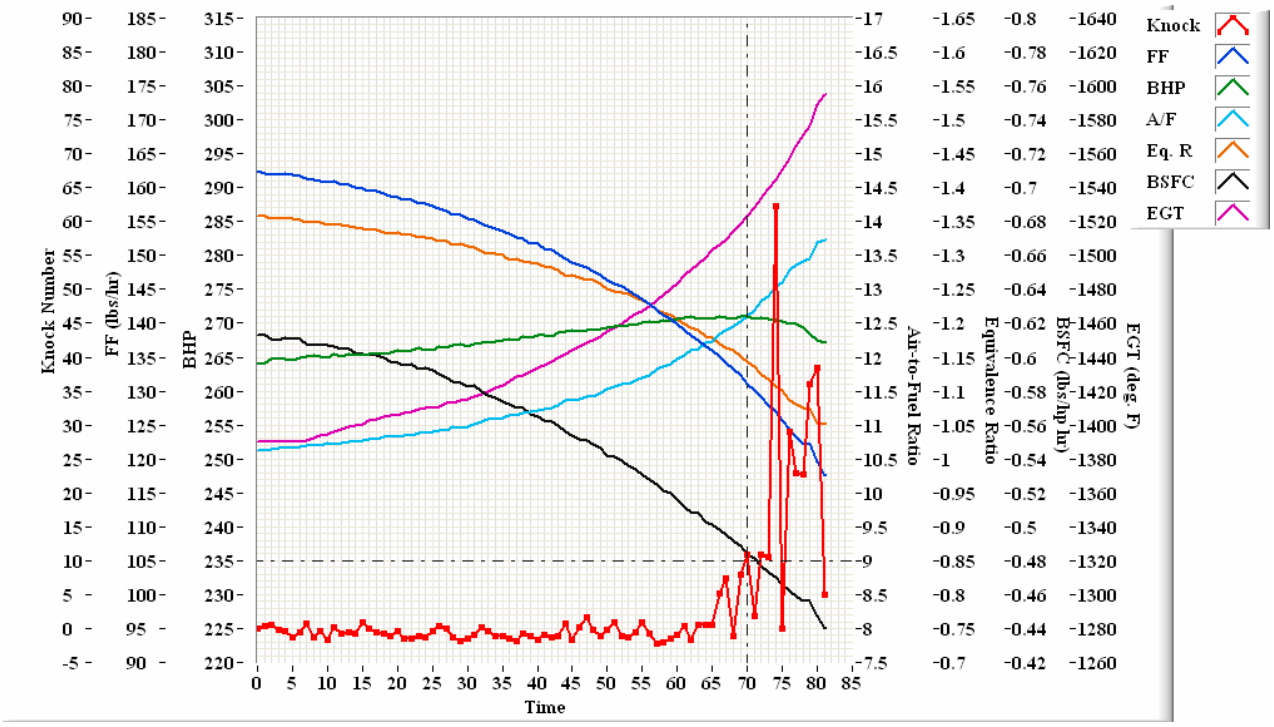


Figure B-25. Blend 7, 2700 rpm

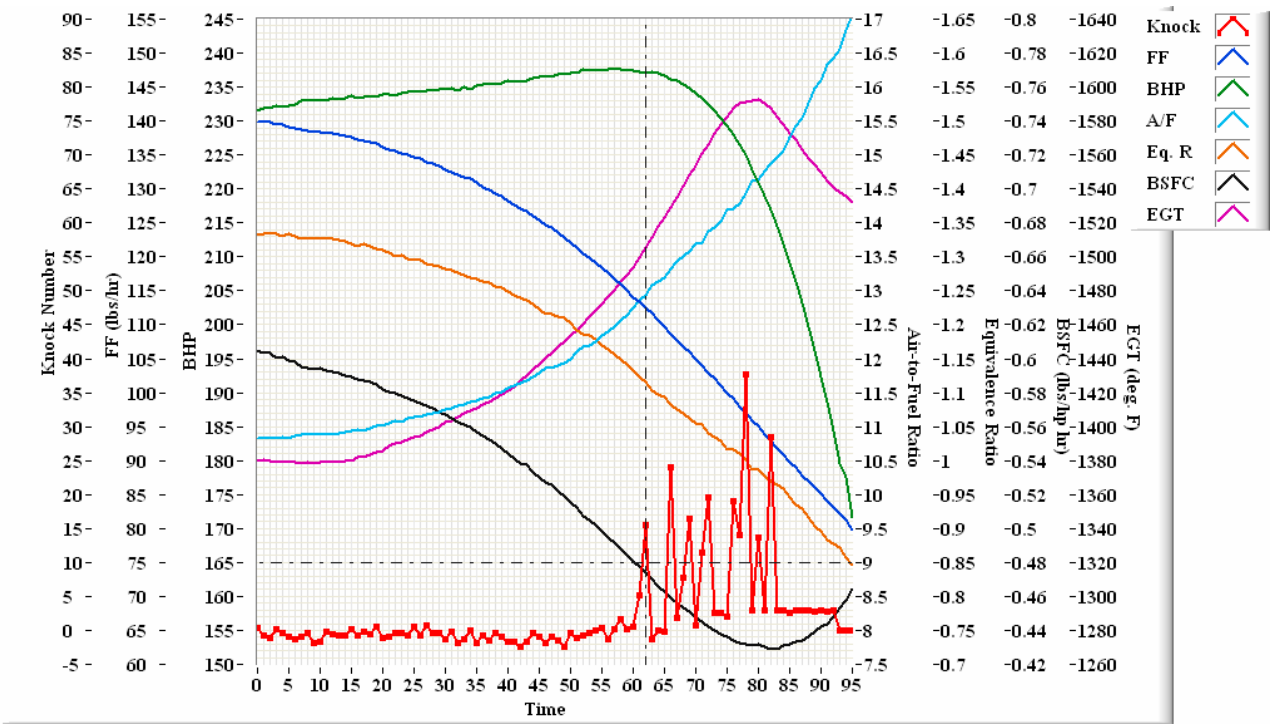


Figure B-26. Blend 7, 2600 rpm

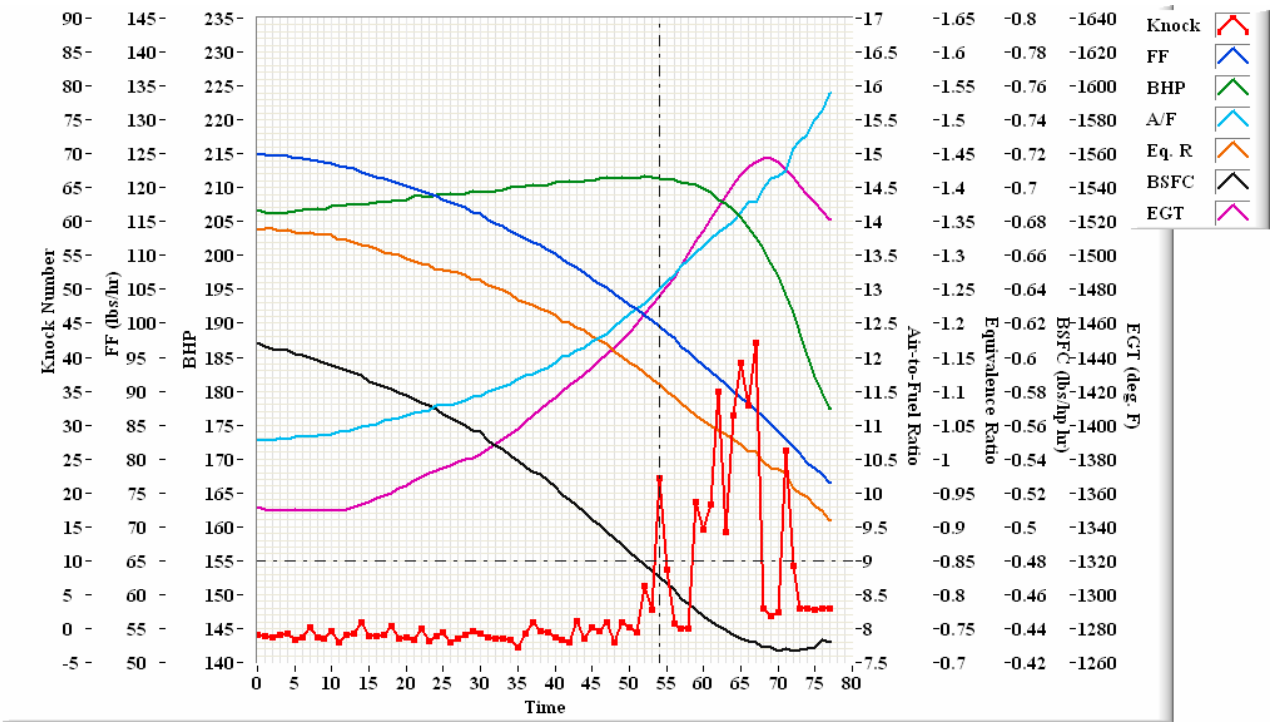


Figure B-27. Blend 7, 2450 rpm

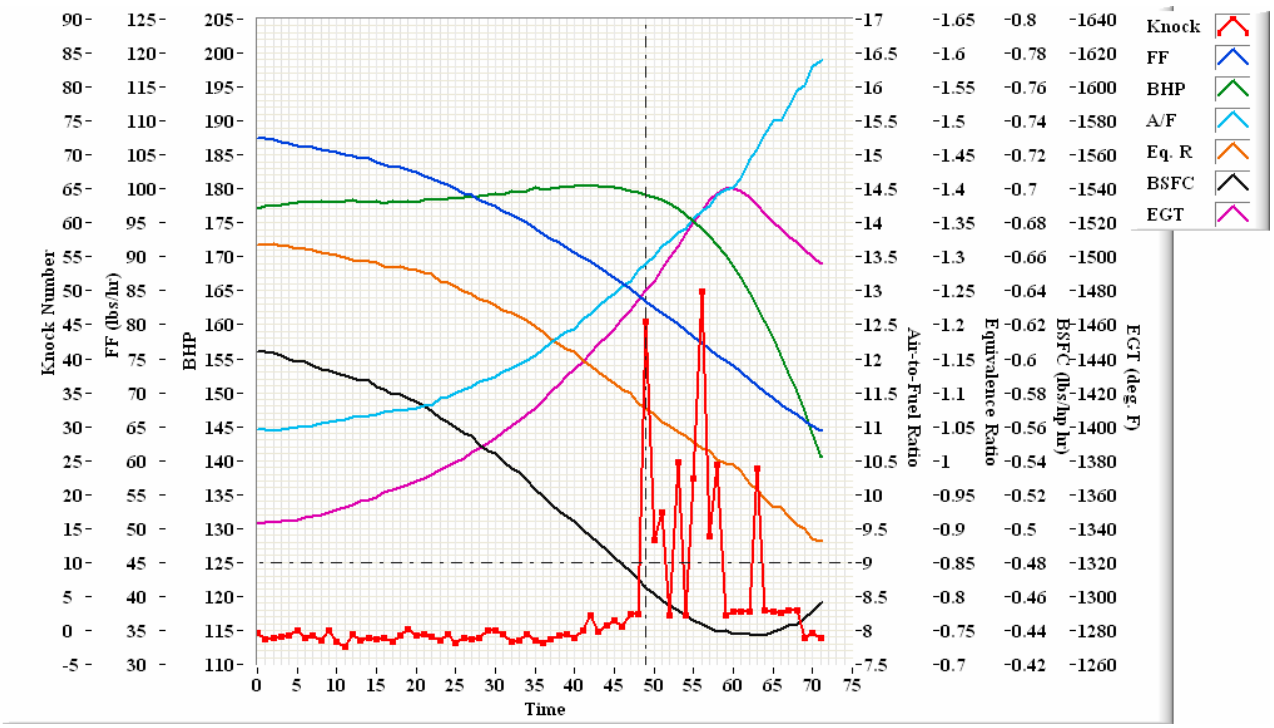


Figure B-28. Blend 7, 2350 rpm

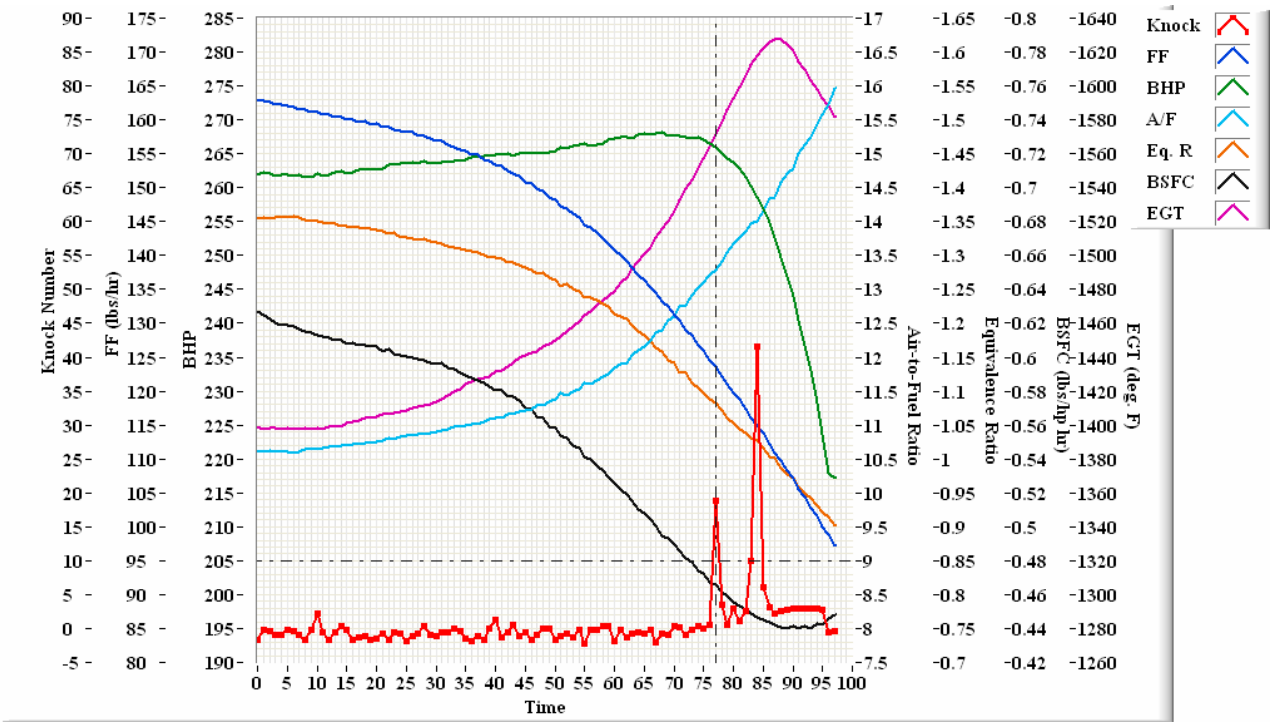


Figure B-29. Blend 8, 2700 rpm

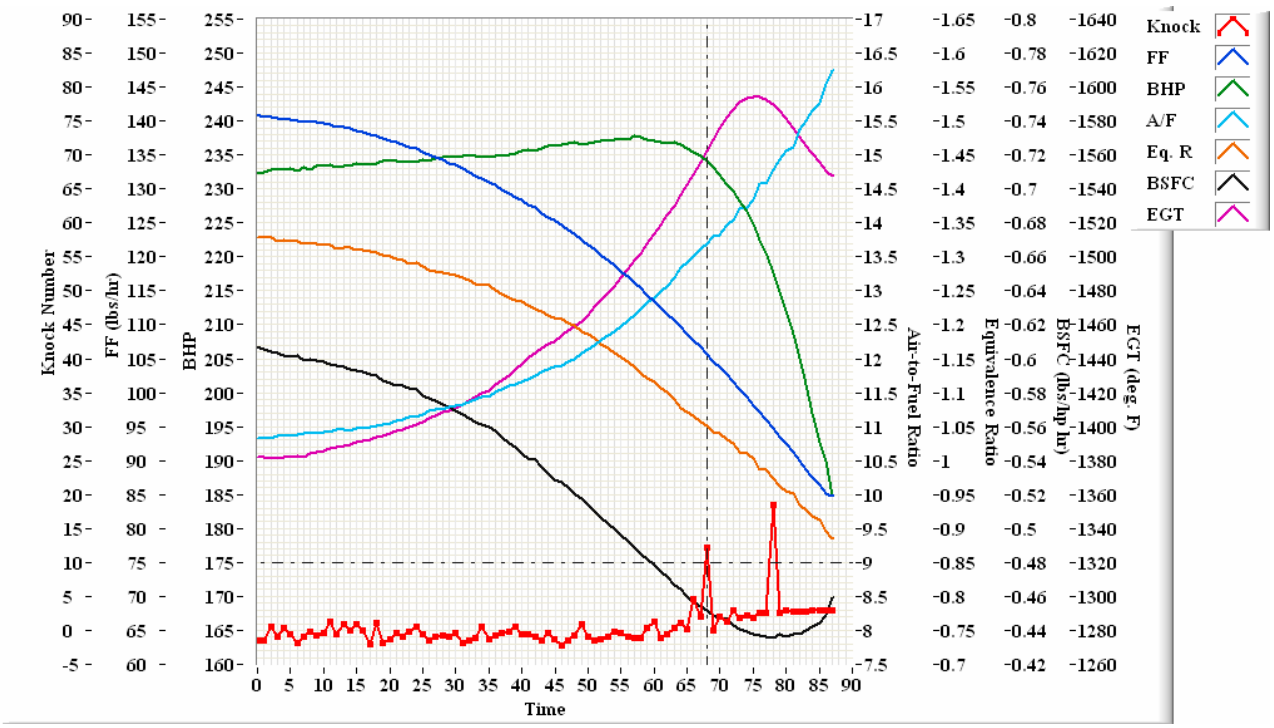


Figure B-30. Blend 8, 2600 rpm

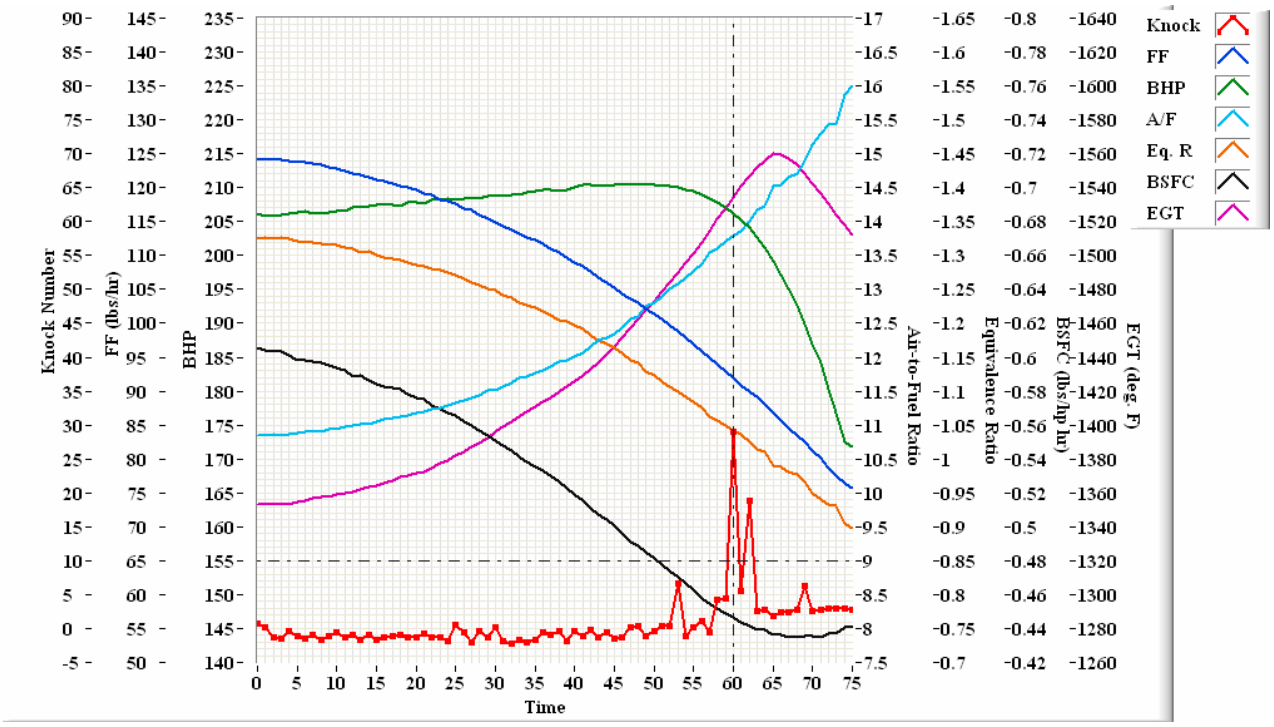


Figure B-31. Blend 8, 2450 rpm

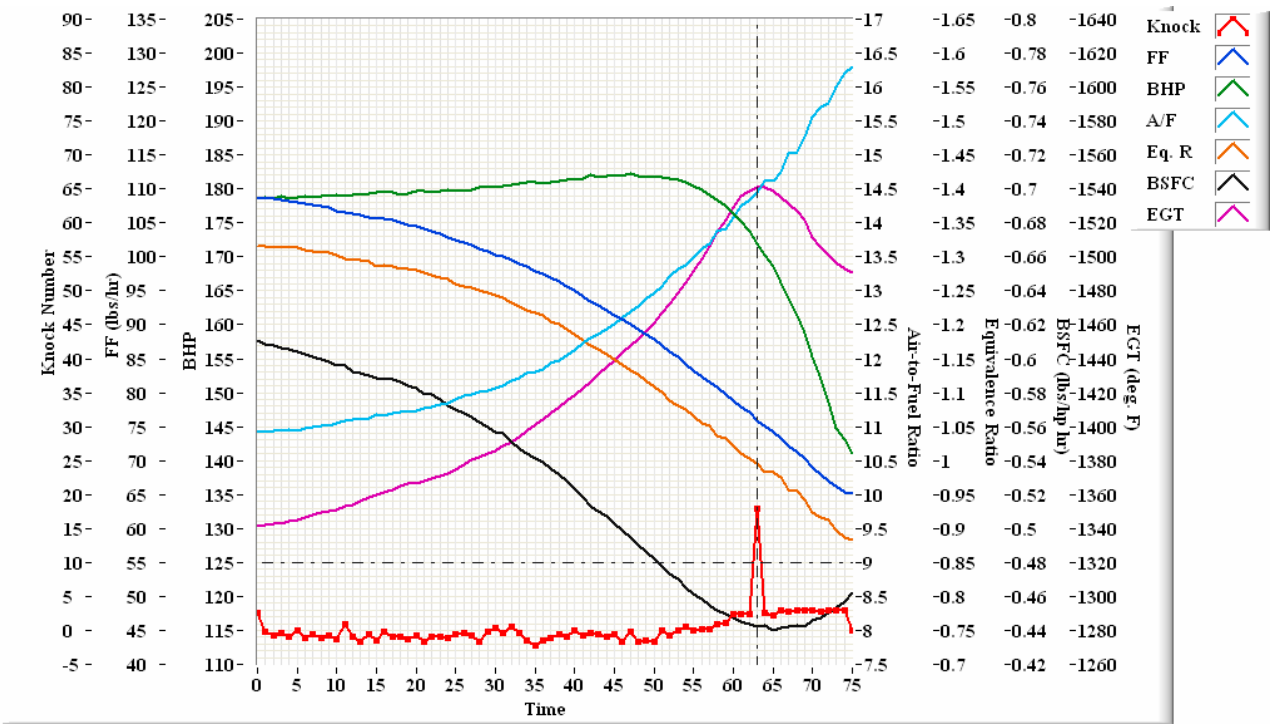


Figure B-32. Blend 8, 2350 rpm

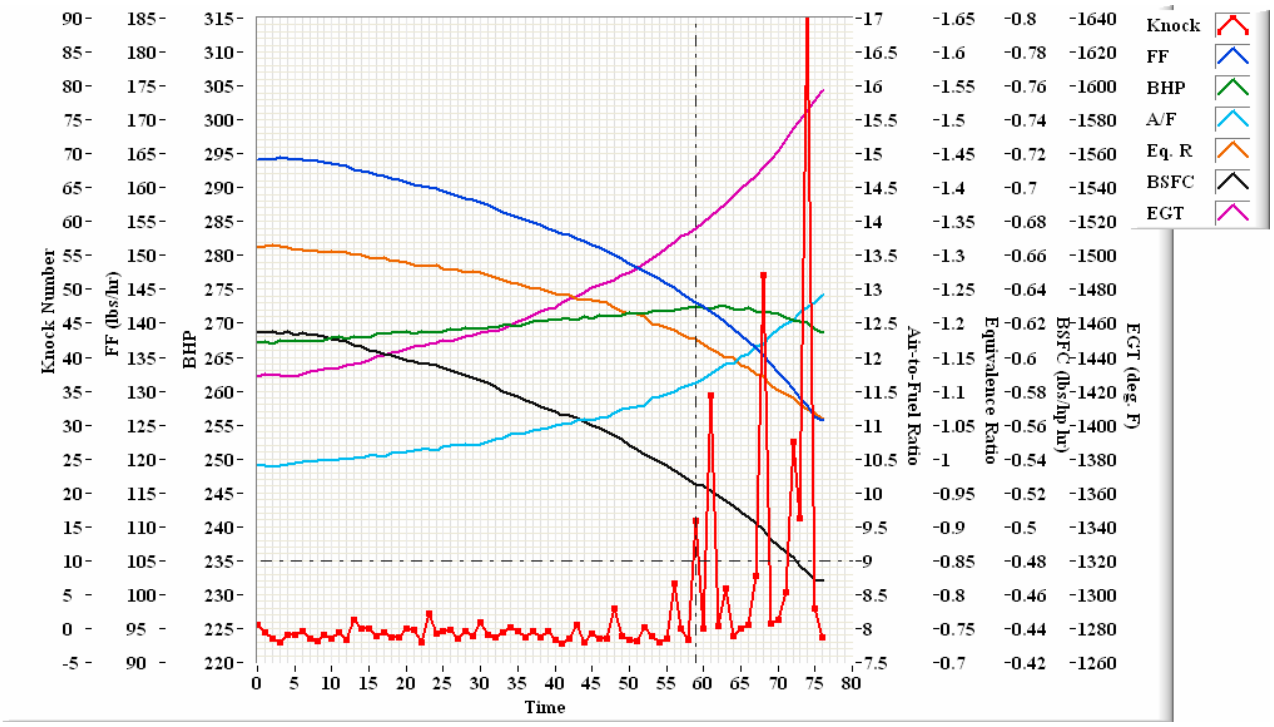


Figure B-33. Blend 9, 2700 rpm

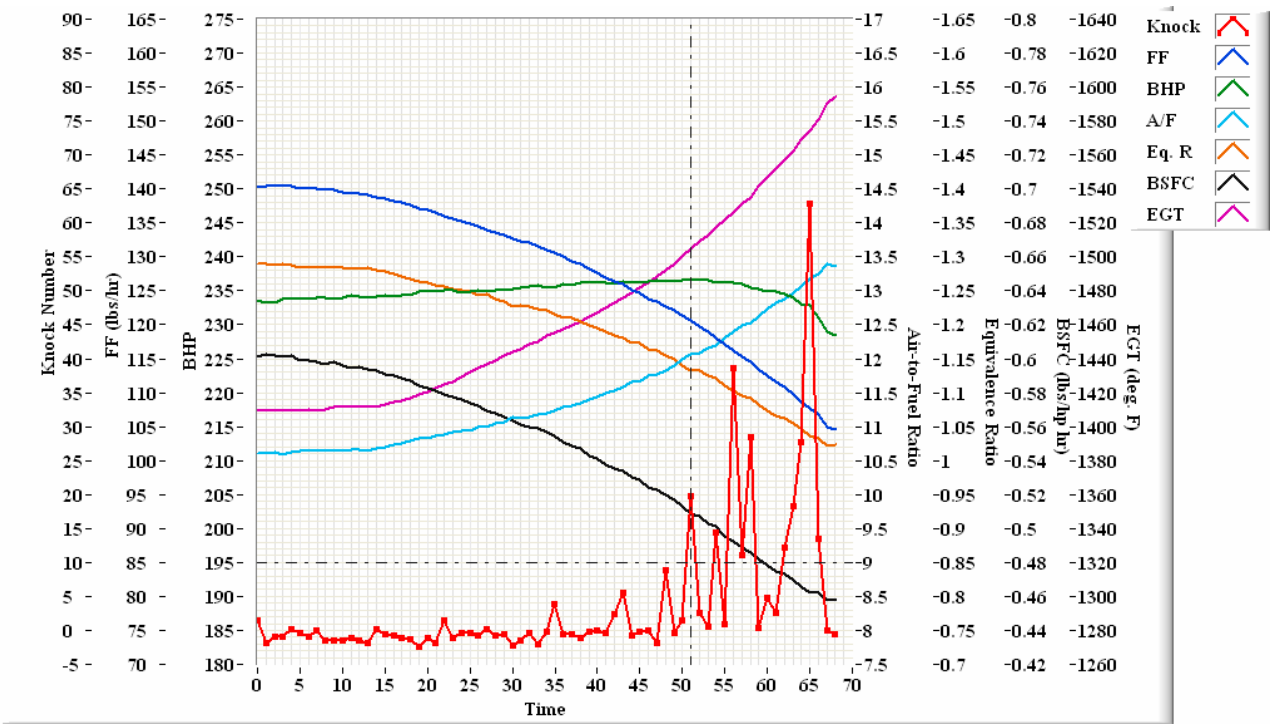


Figure B-34. Blend 9, 2600 rpm

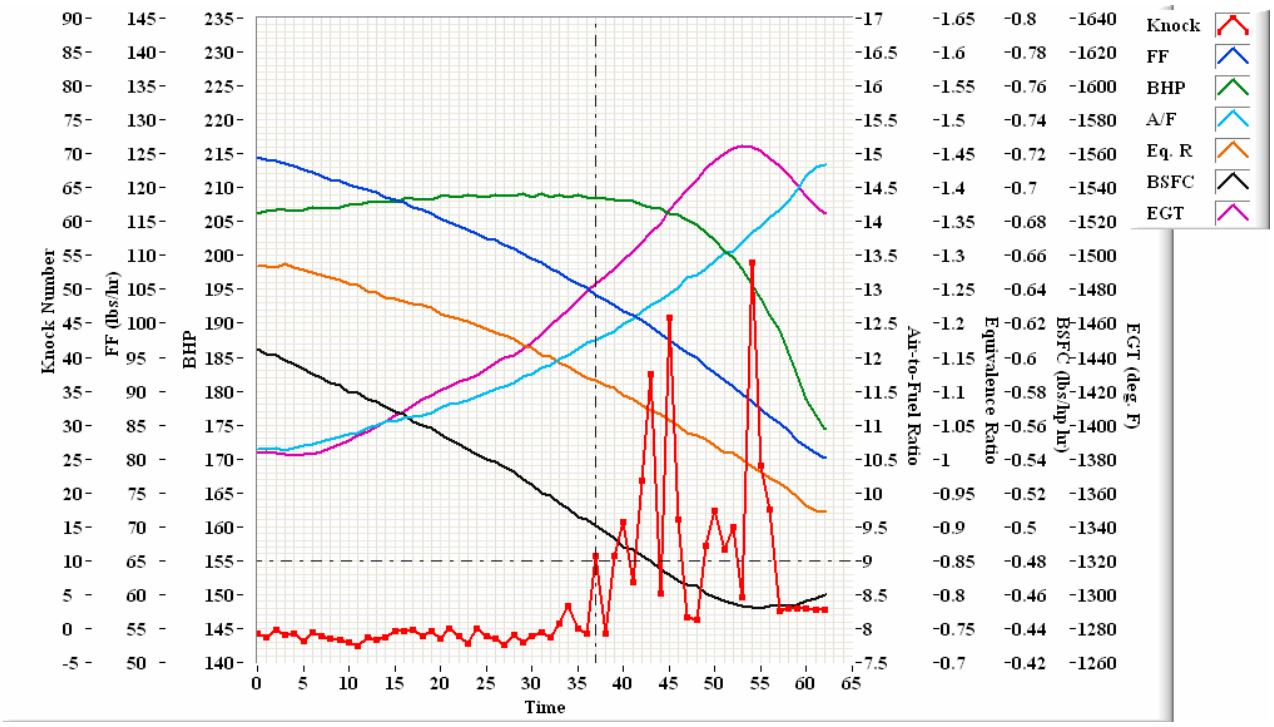


Figure B-35. Blend 9, 2450 rpm

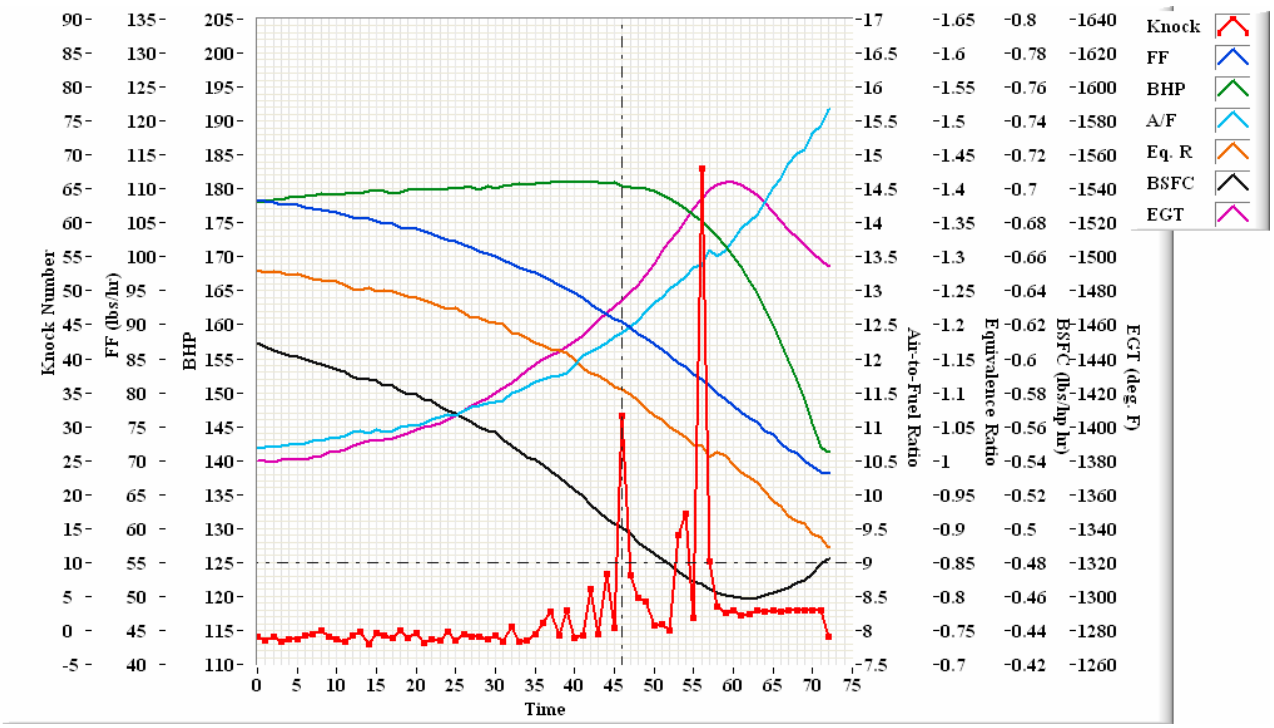


Figure B-36. Blend 9, 2350 rpm

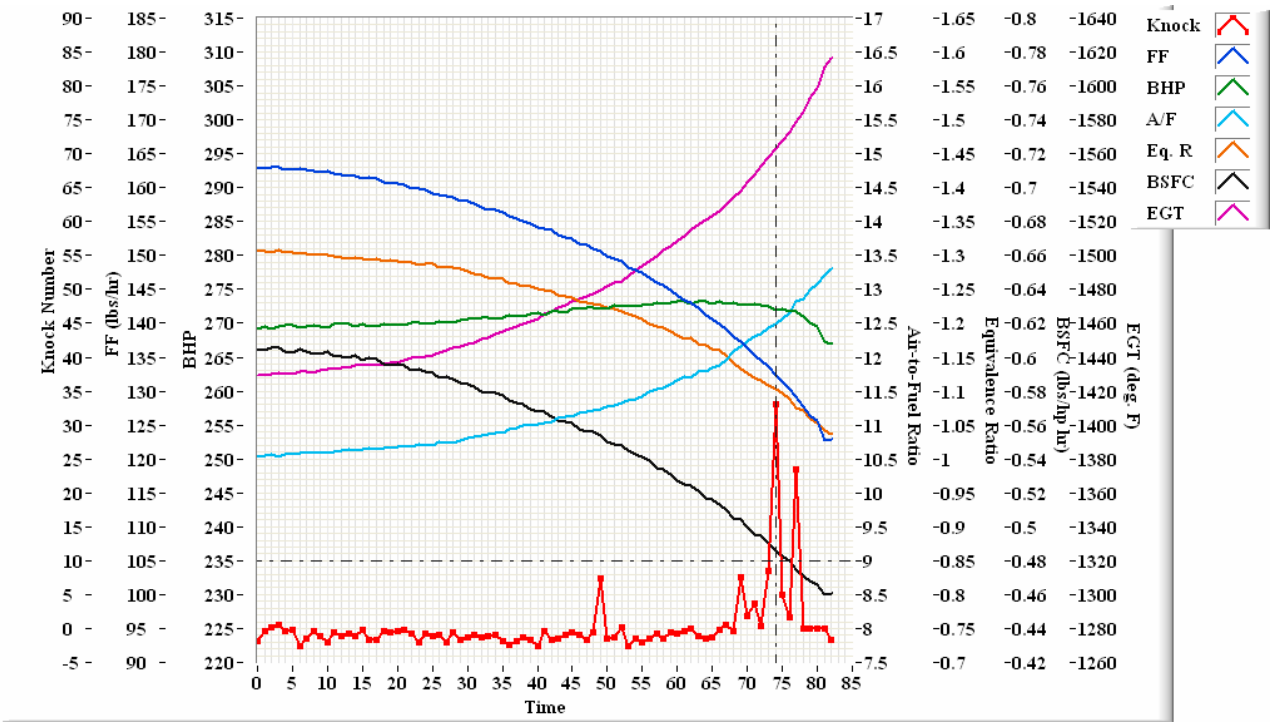


Figure B-37. Blend 10, 2700 rpm

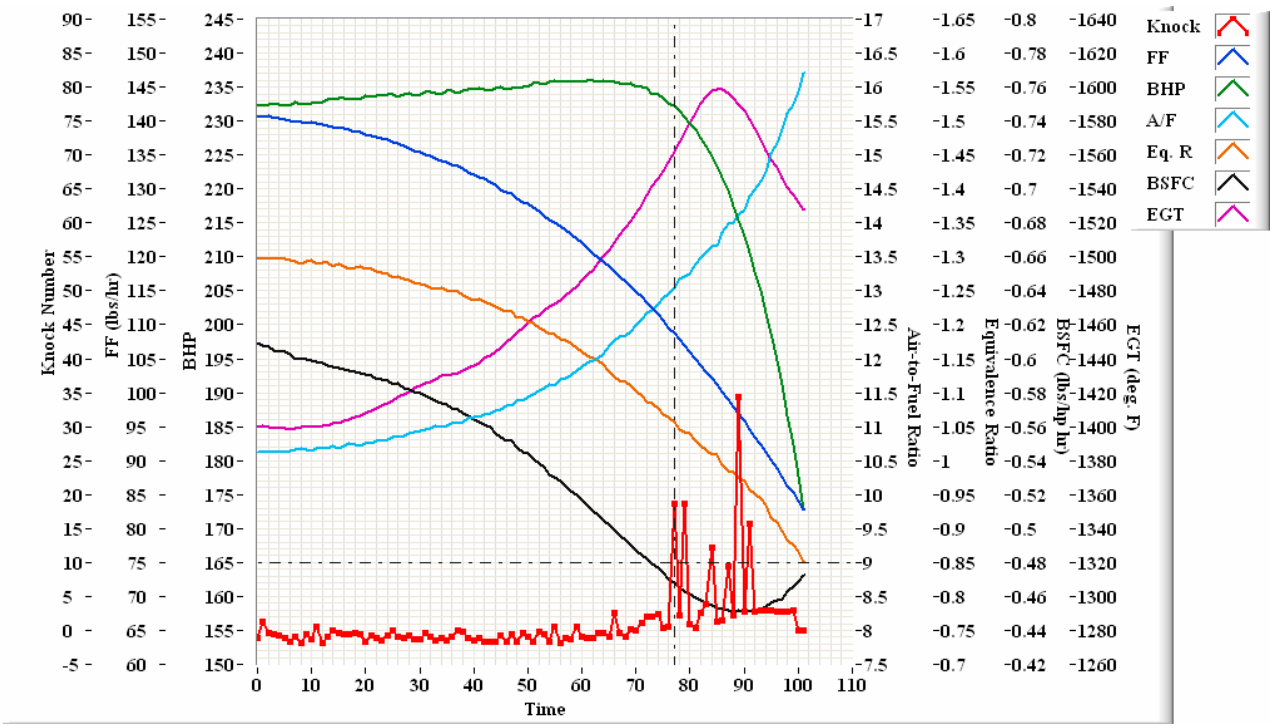


Figure B-38. Blend 10, 2600 rpm

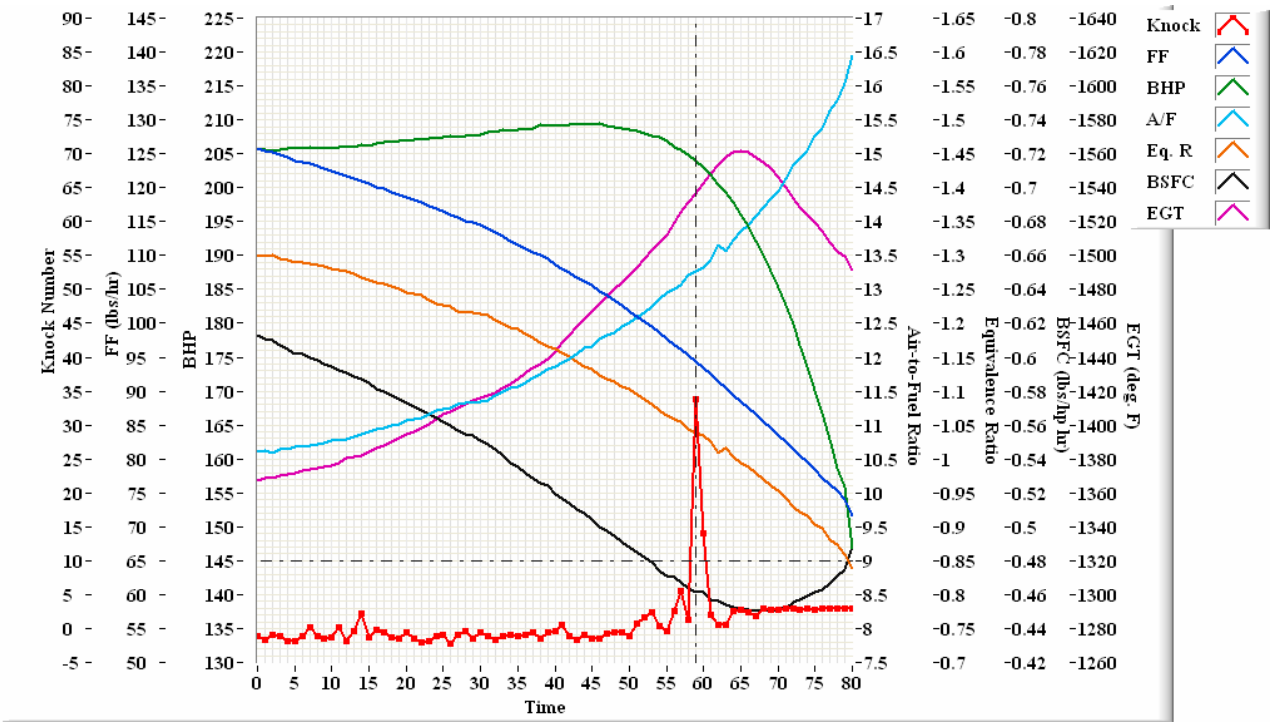


Figure B-39. Blend 10, 2450 rpm

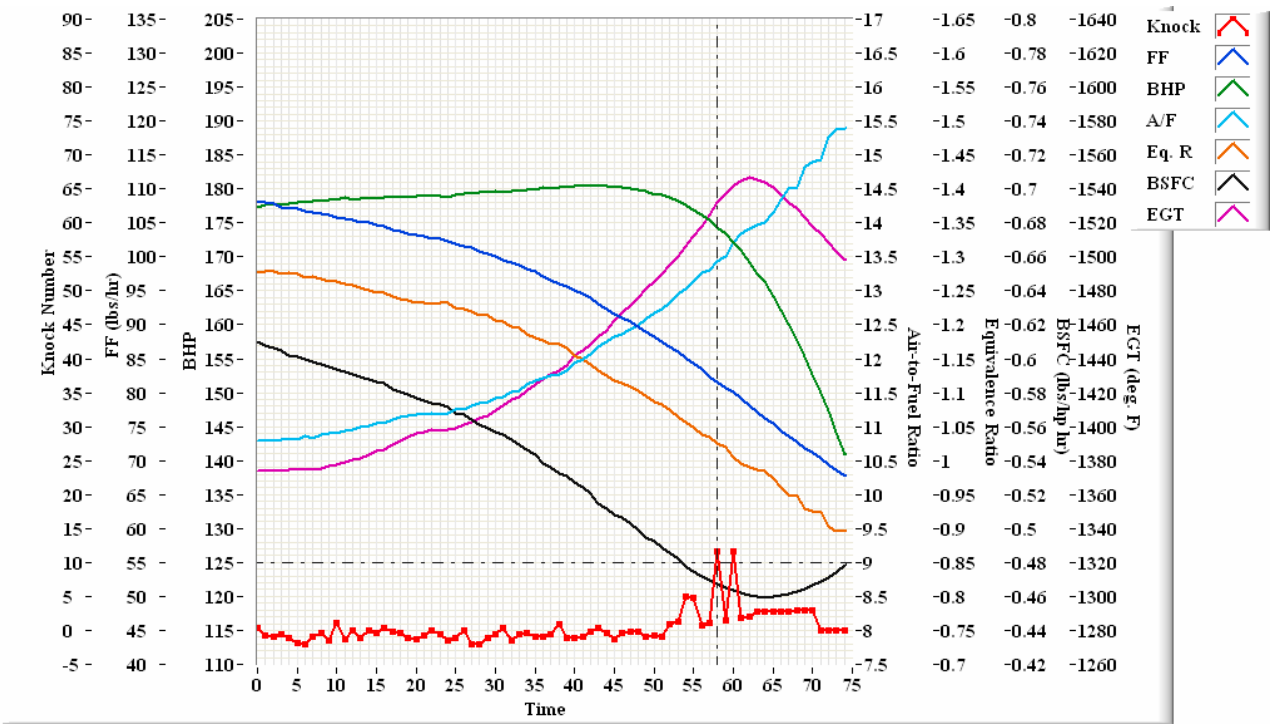


Figure B-40. Blend 10, 2350 rpm

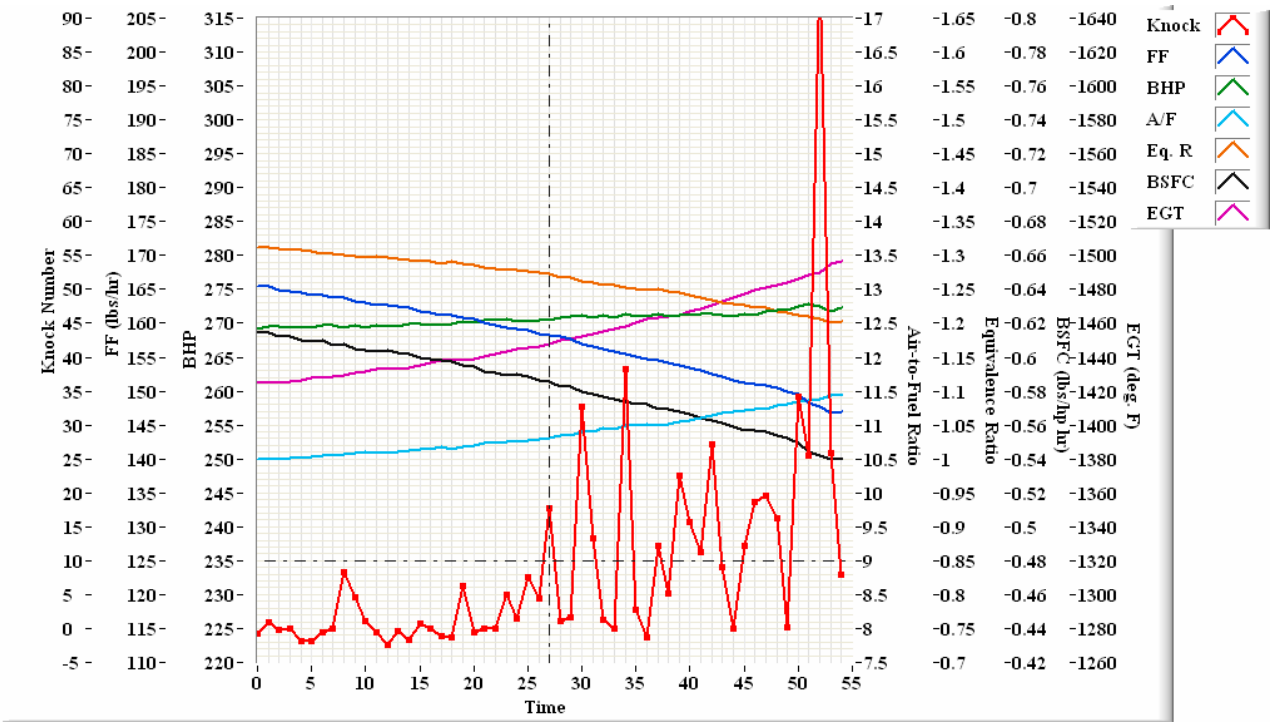


Figure B-41. Blend 11, 2700 rpm

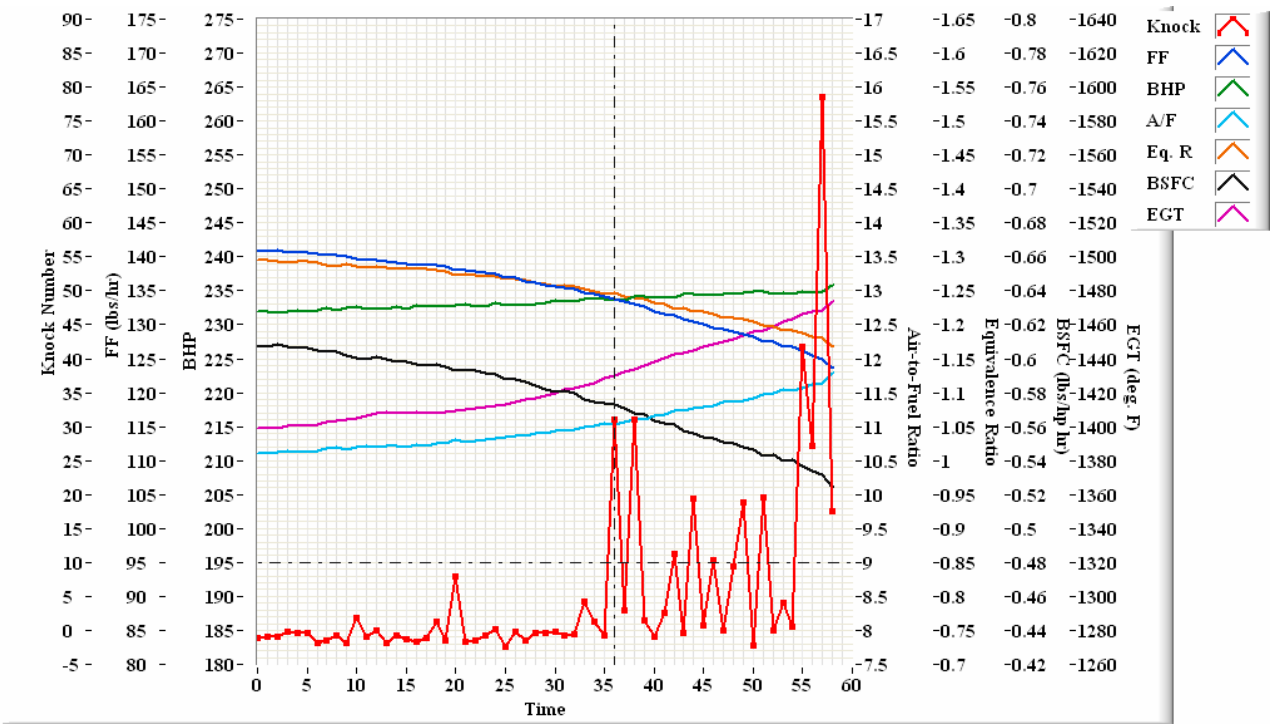


Figure B-42. Blend 11, 2600 rpm

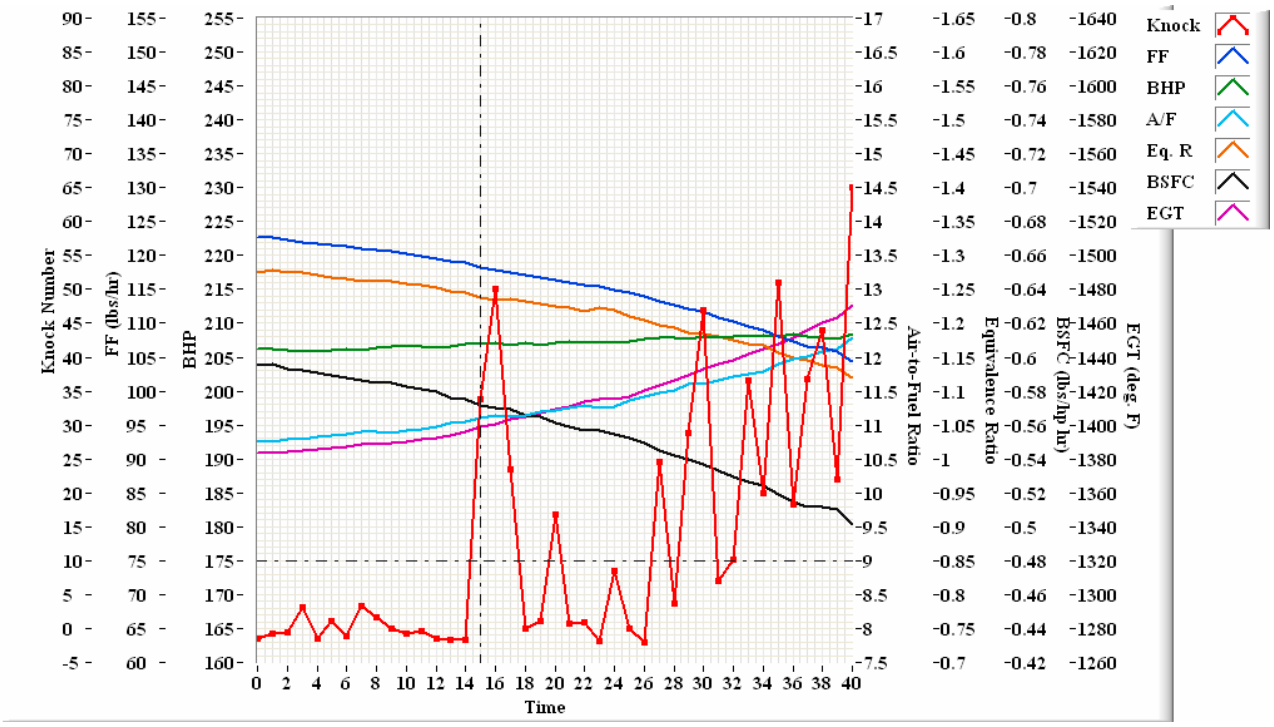


Figure B-43. Blend 11, 2450 rpm

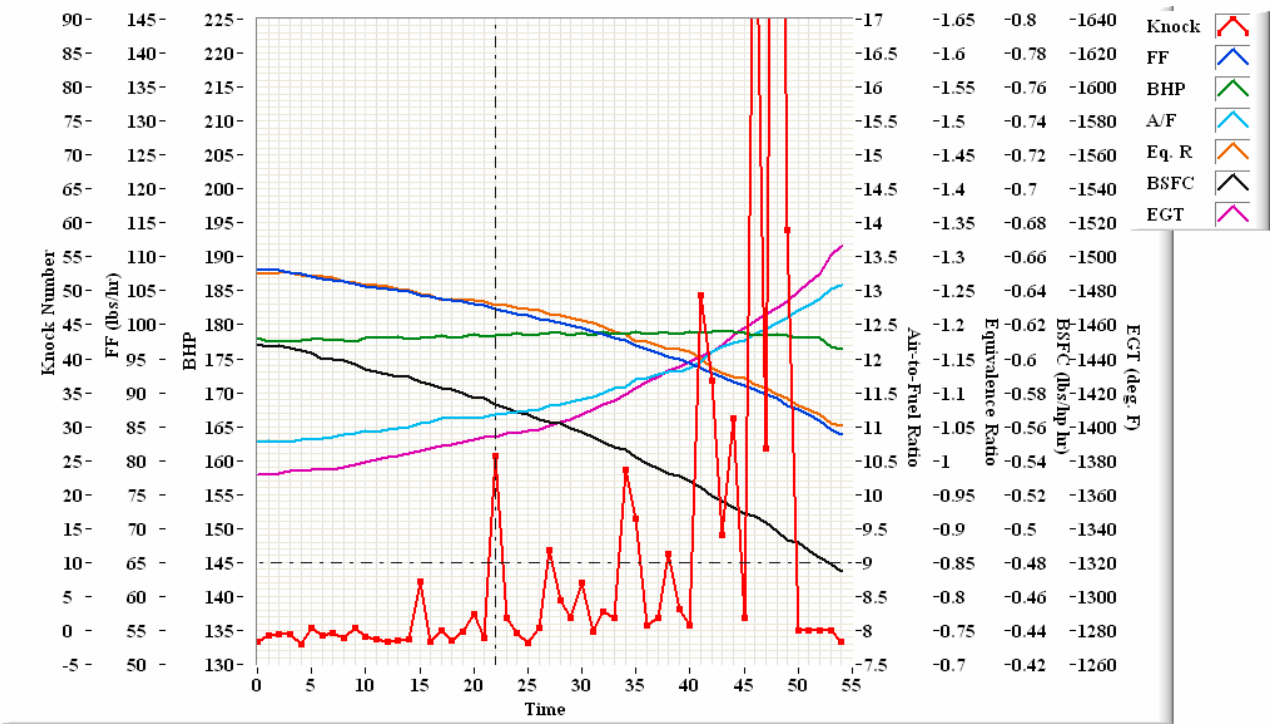


Figure B-44. Blend 11, 2350 rpm

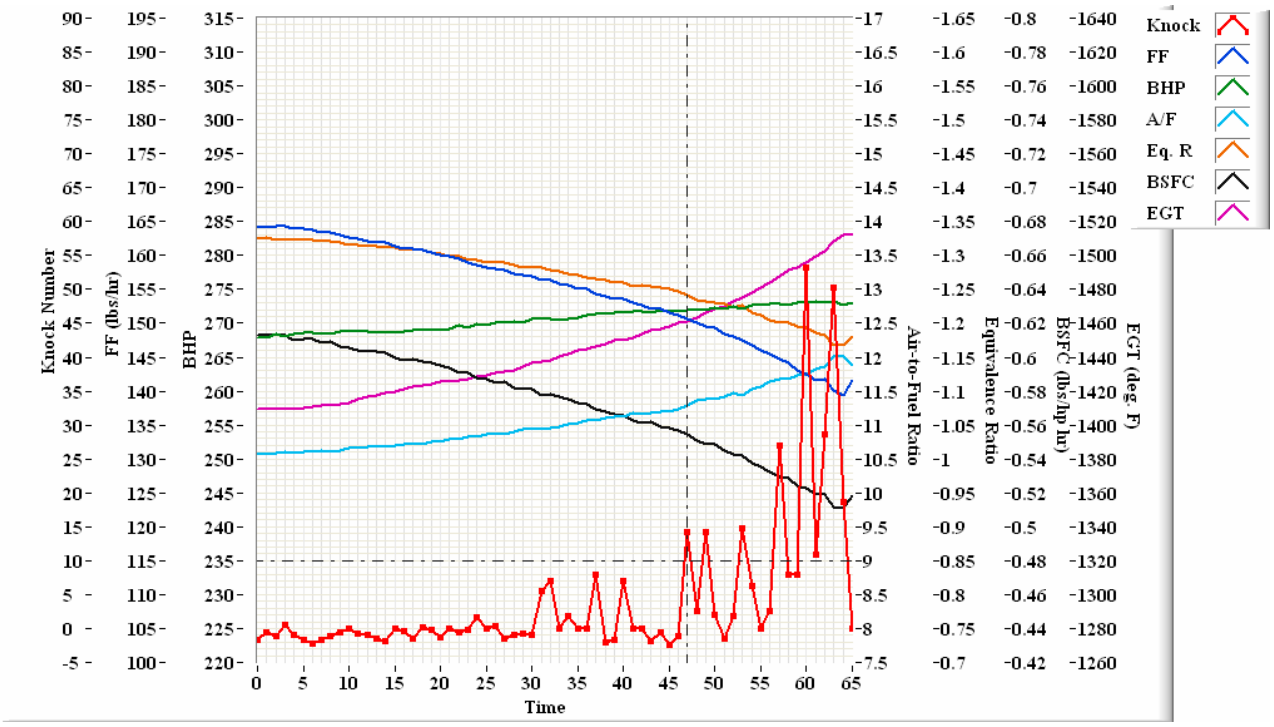


Figure B-45. Blend 12, 2700 rpm

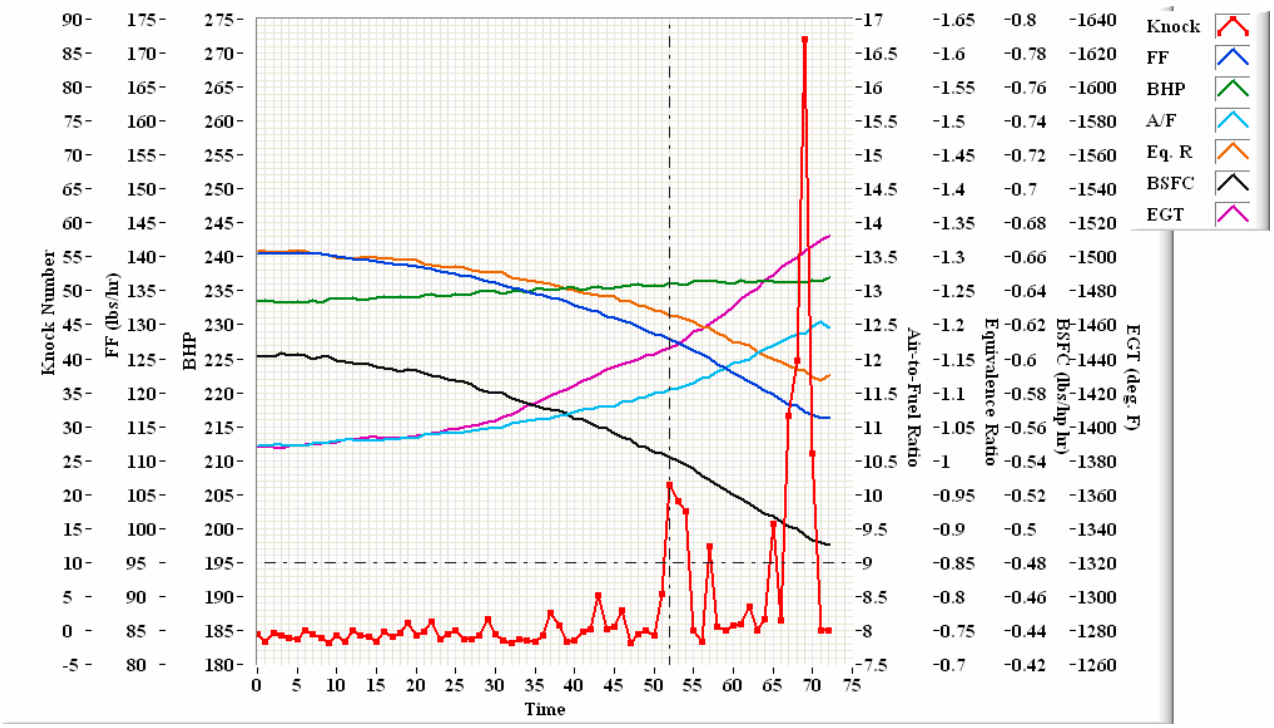


Figure B-46. Blend 12, 2600 rpm

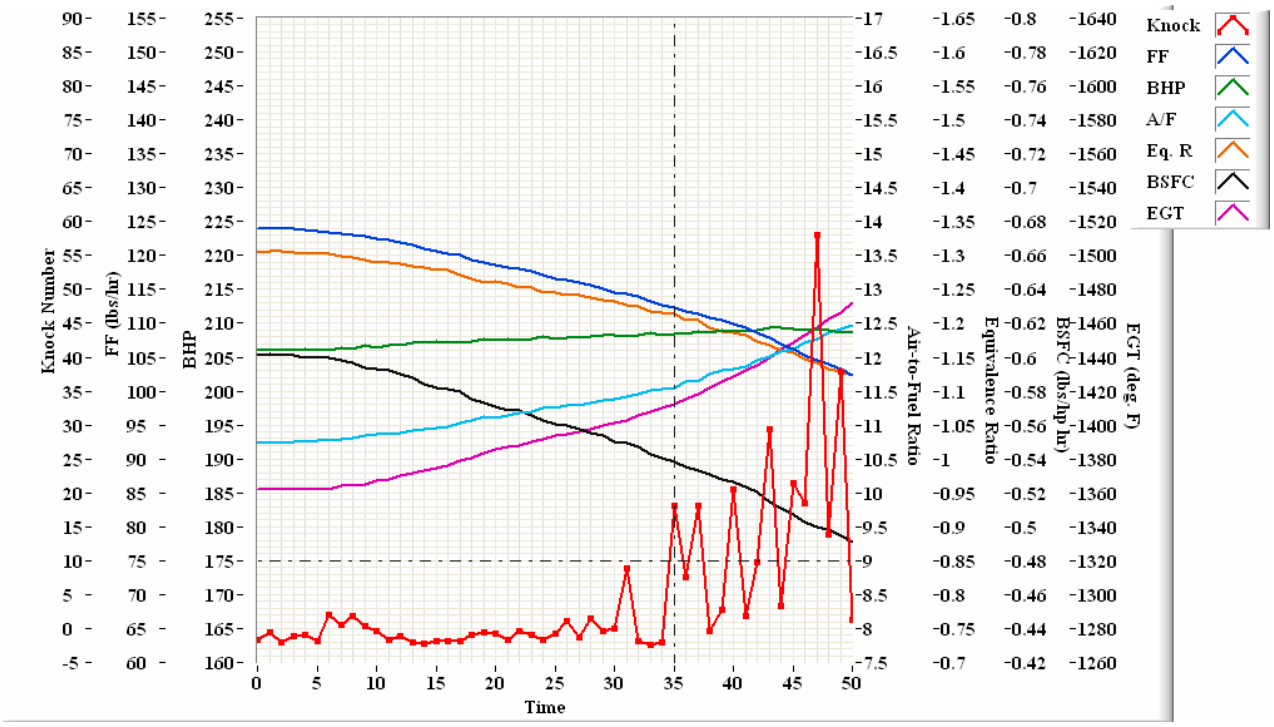


Figure B-47. Blend 12, 2450 rpm

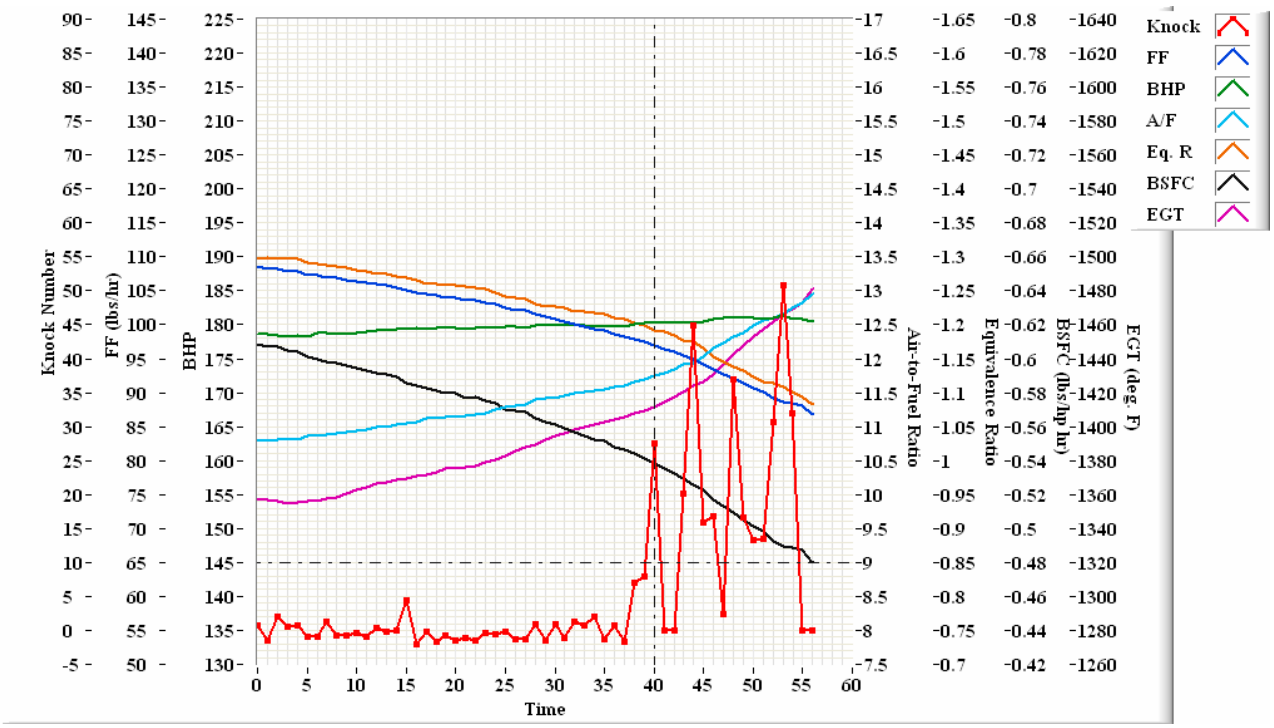


Figure B-48. Blend 12, 2350 rpm

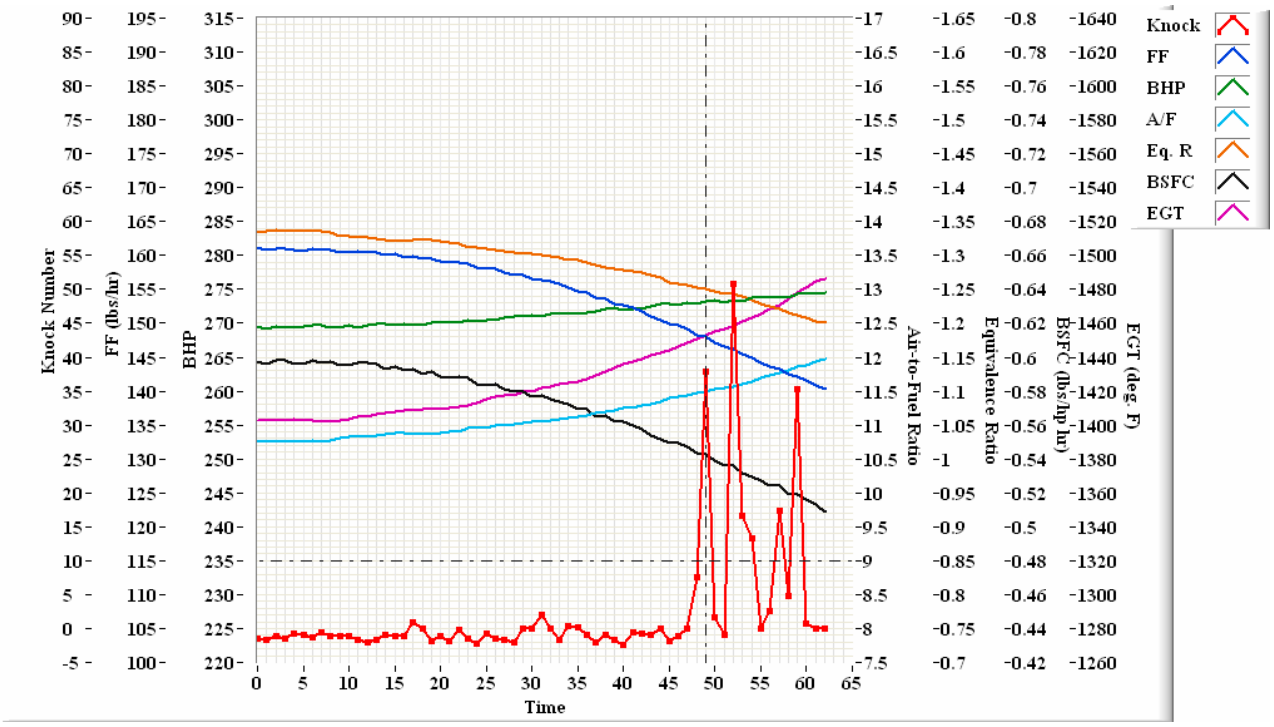


Figure B-49. Blend 13, 2700 rpm

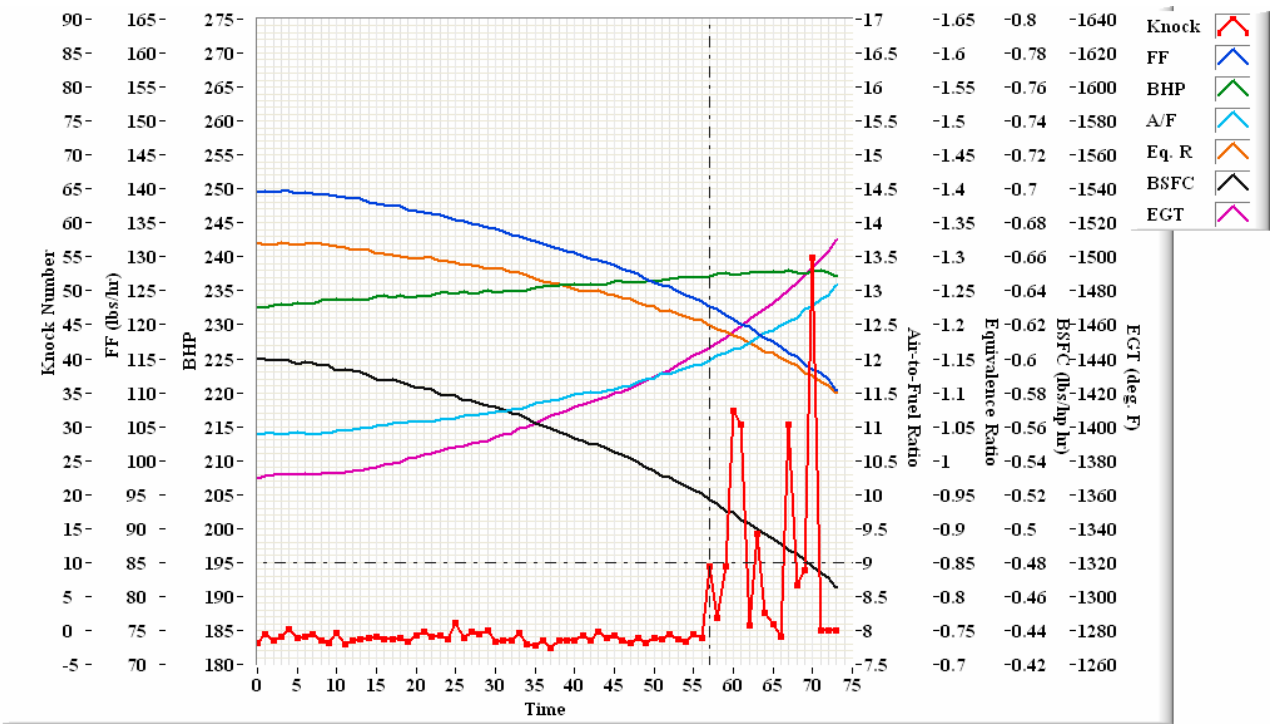


Figure B-50. Blend 13, 2600 rpm

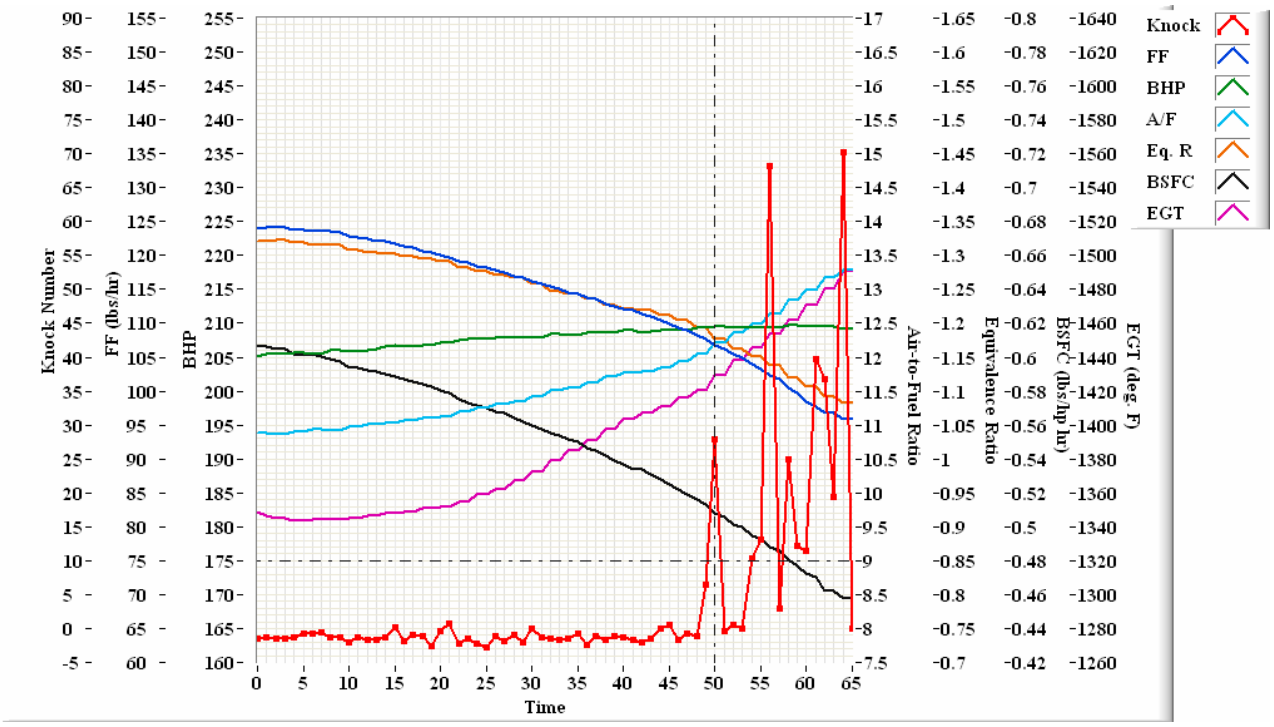


Figure B-51. Blend 13, 2450 rpm

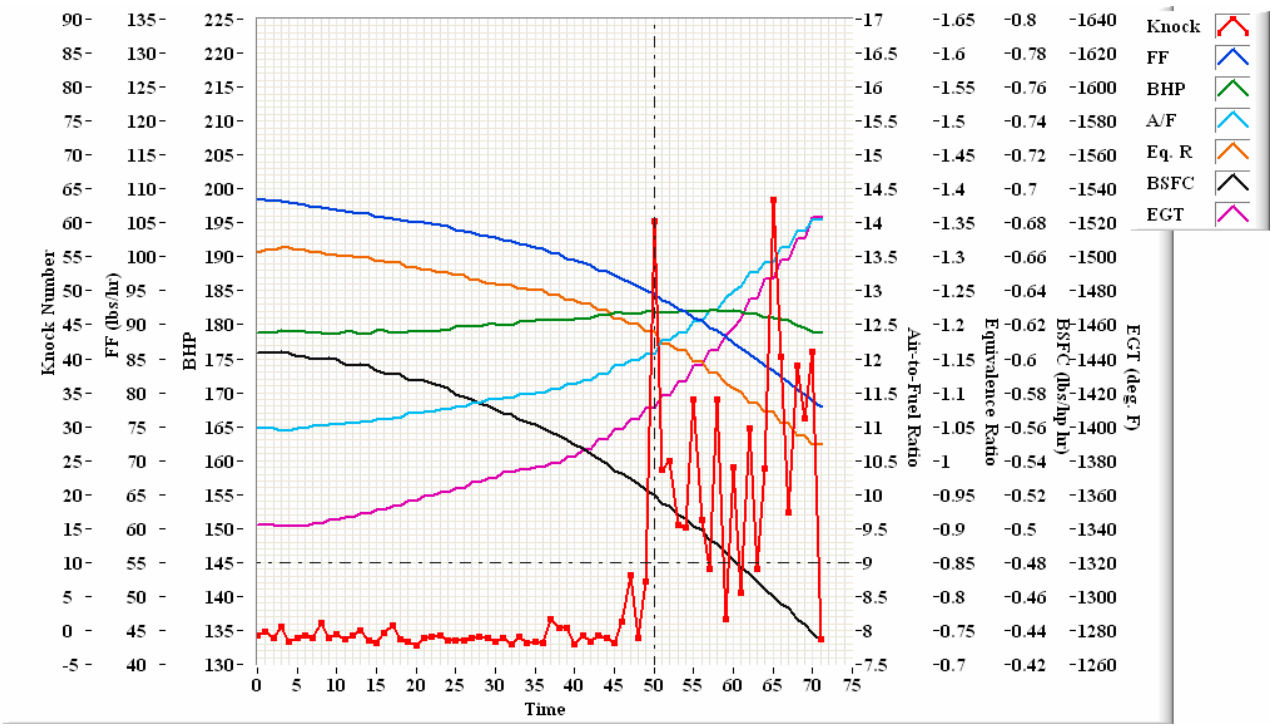


Figure B-52. Blend 13, 2350 rpm

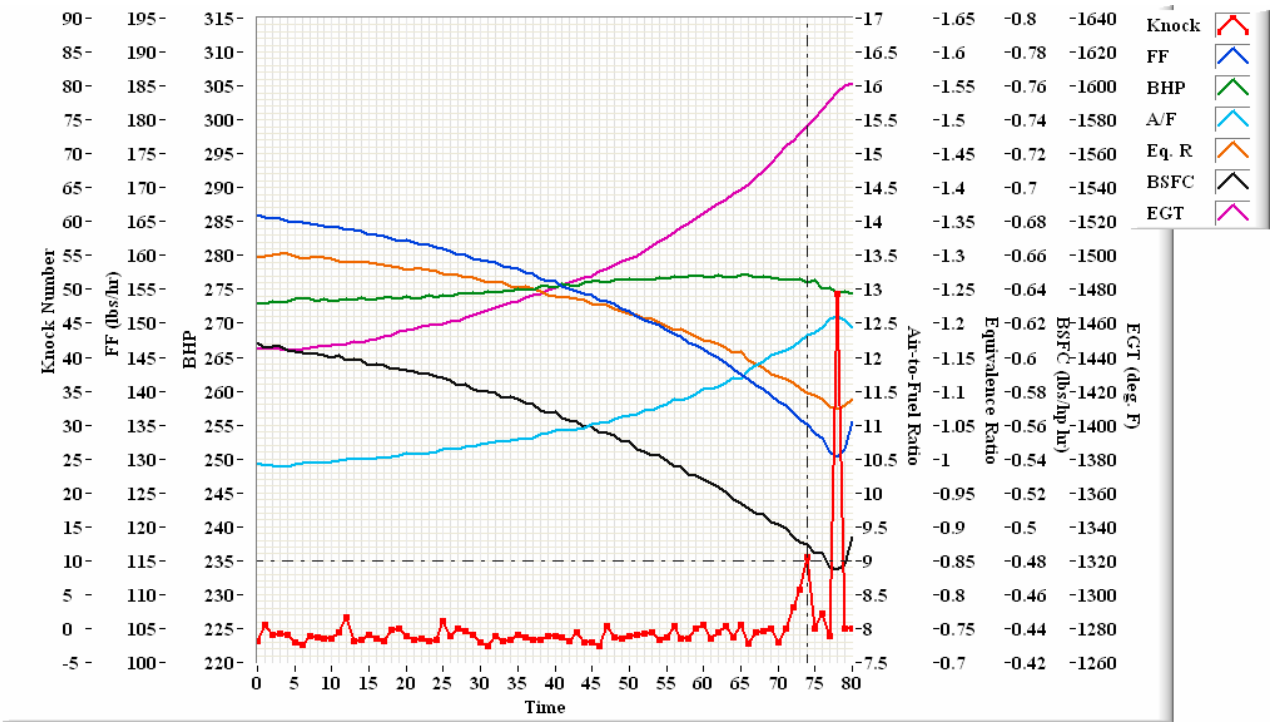


Figure B-53. Blend 14, 2700 rpm

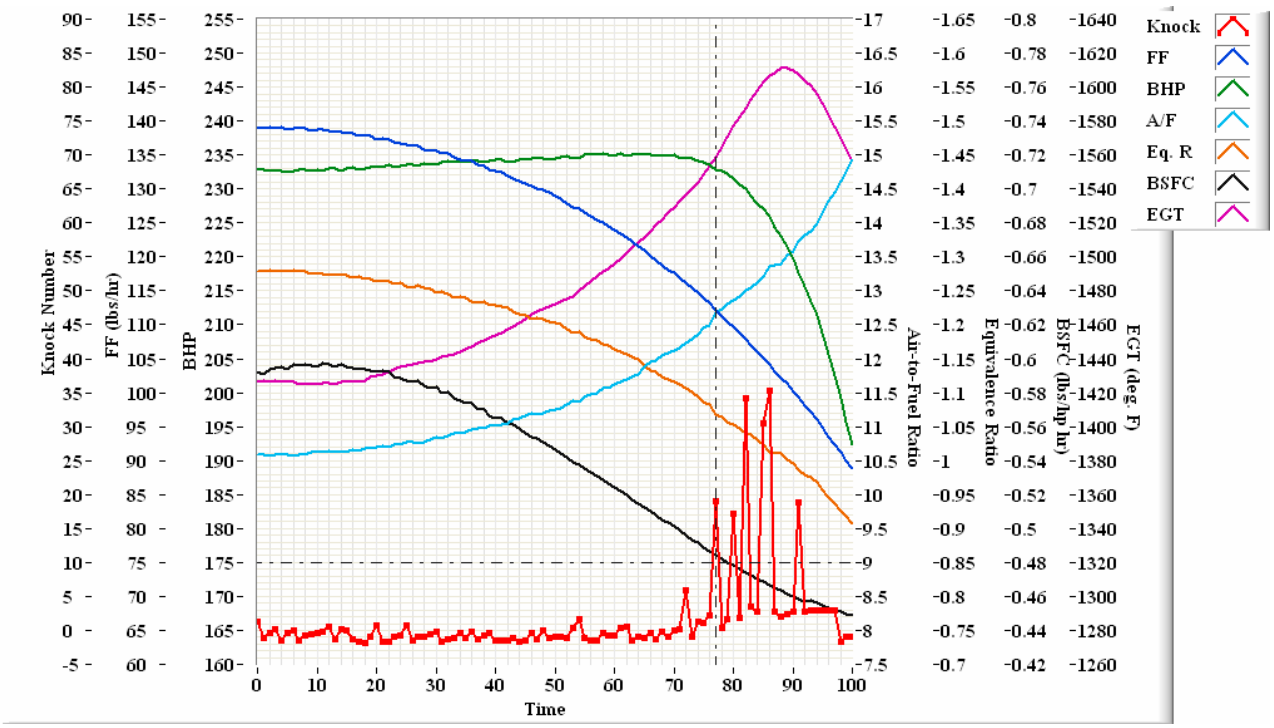


Figure B-54. Blend 14, 2600 rpm

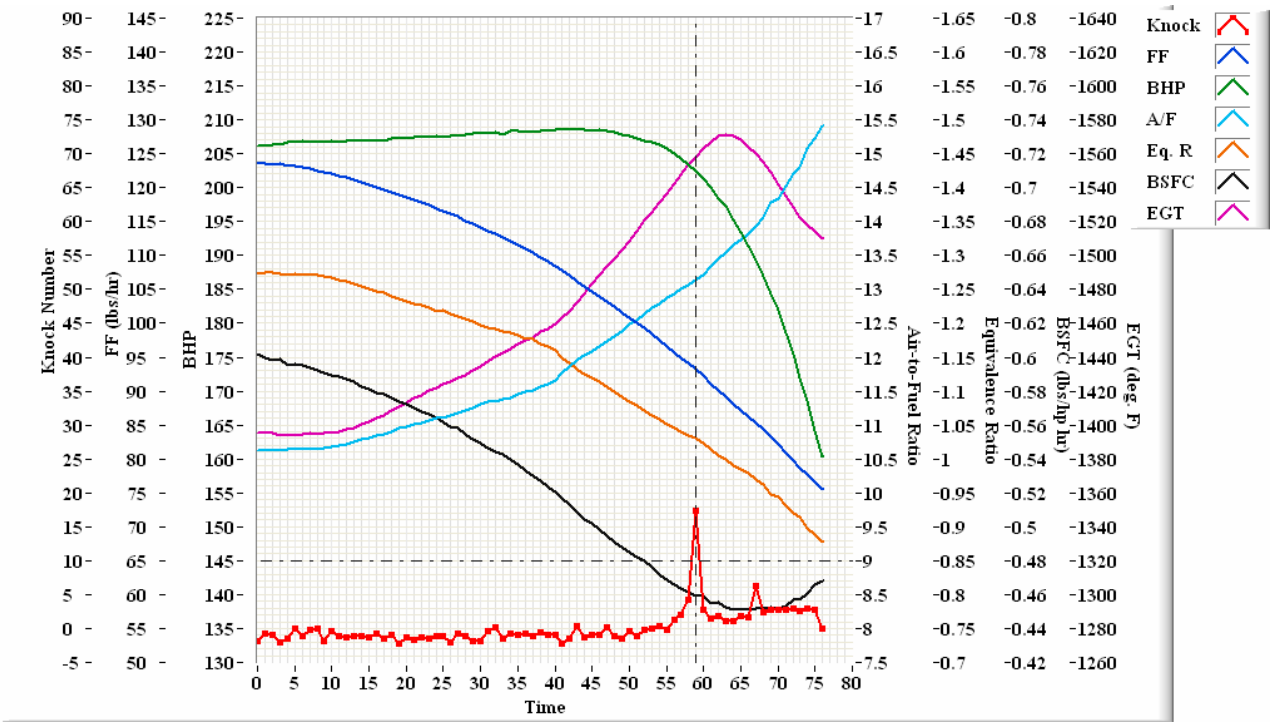


Figure B-55. Blend 14, 2450 rpm

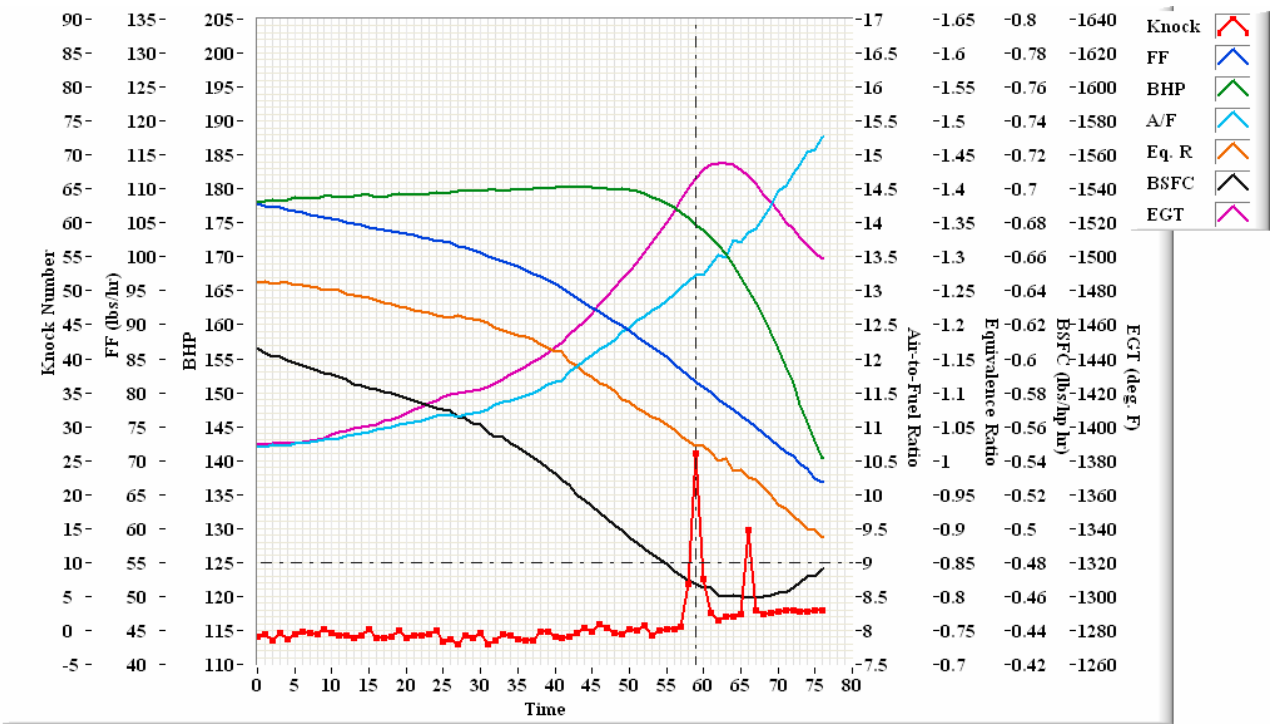


Figure B-56. Blend 14, 2350 rpm

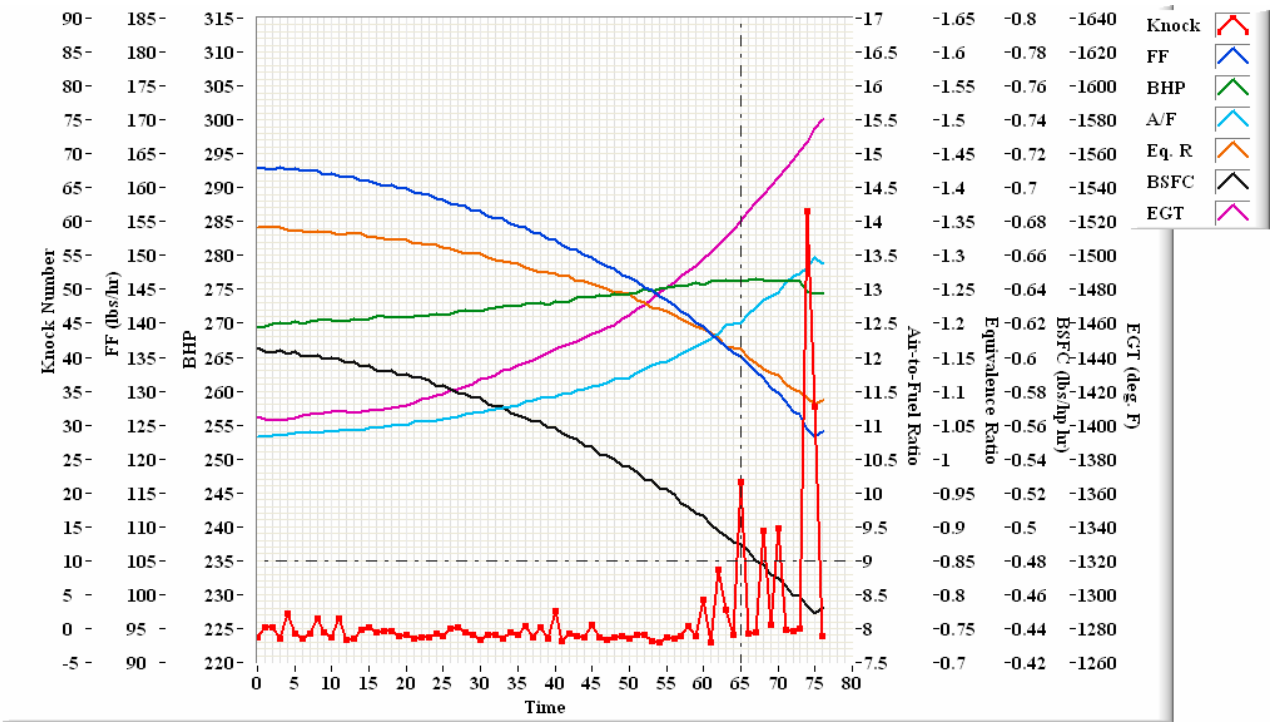


Figure B-57. Blend 16, 2700 rpm

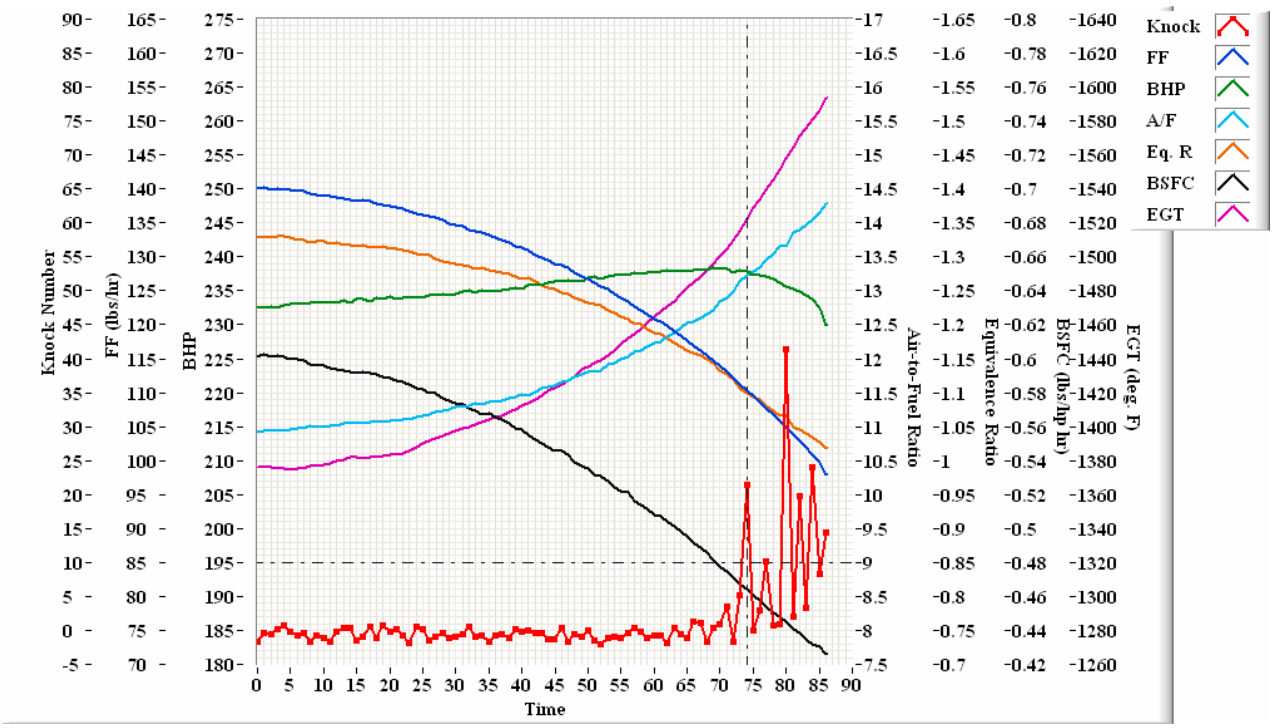


Figure B-58. Blend 16, 2600 rpm

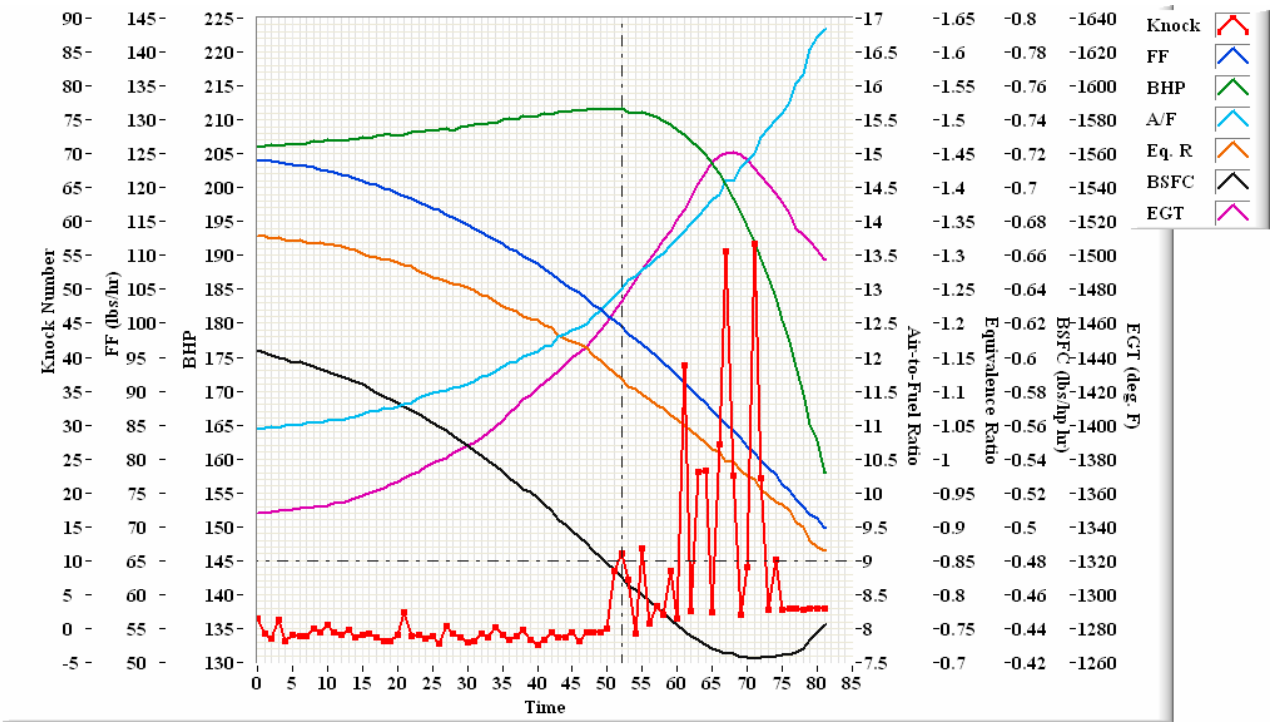


Figure B-59. Blend 16, 2450 rpm

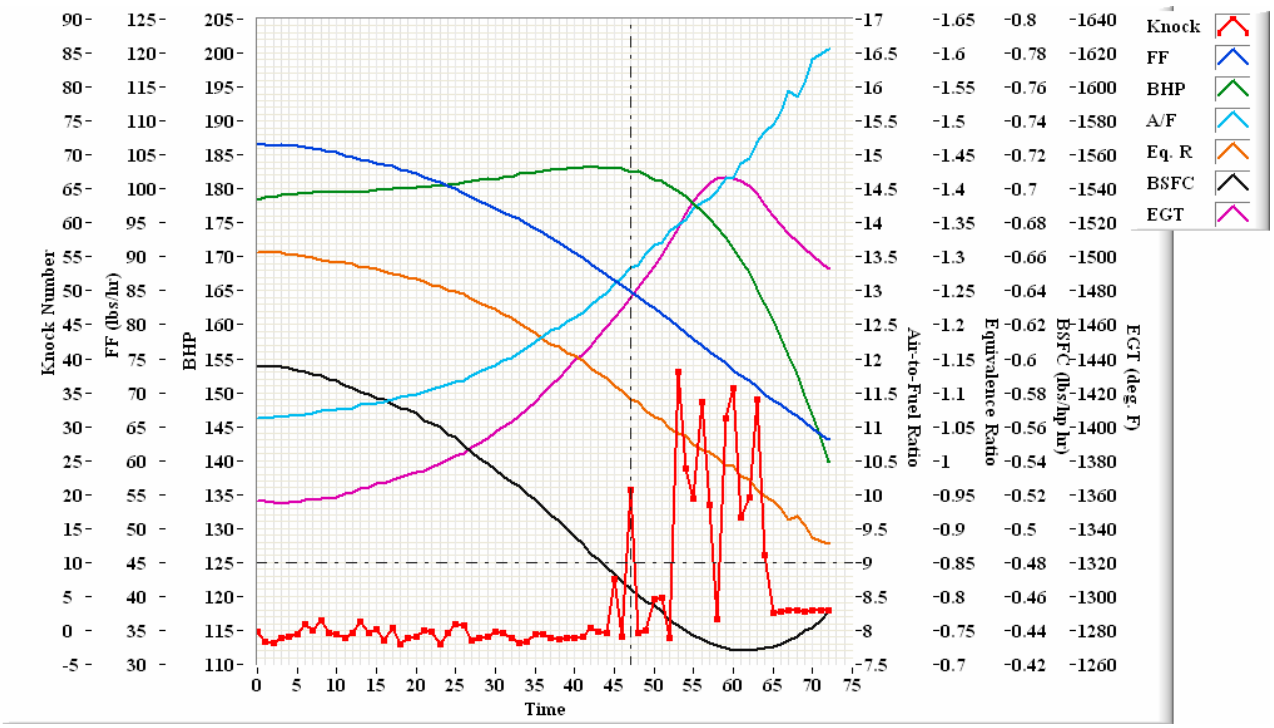


Figure B-60. Blend 16, 2350 rpm

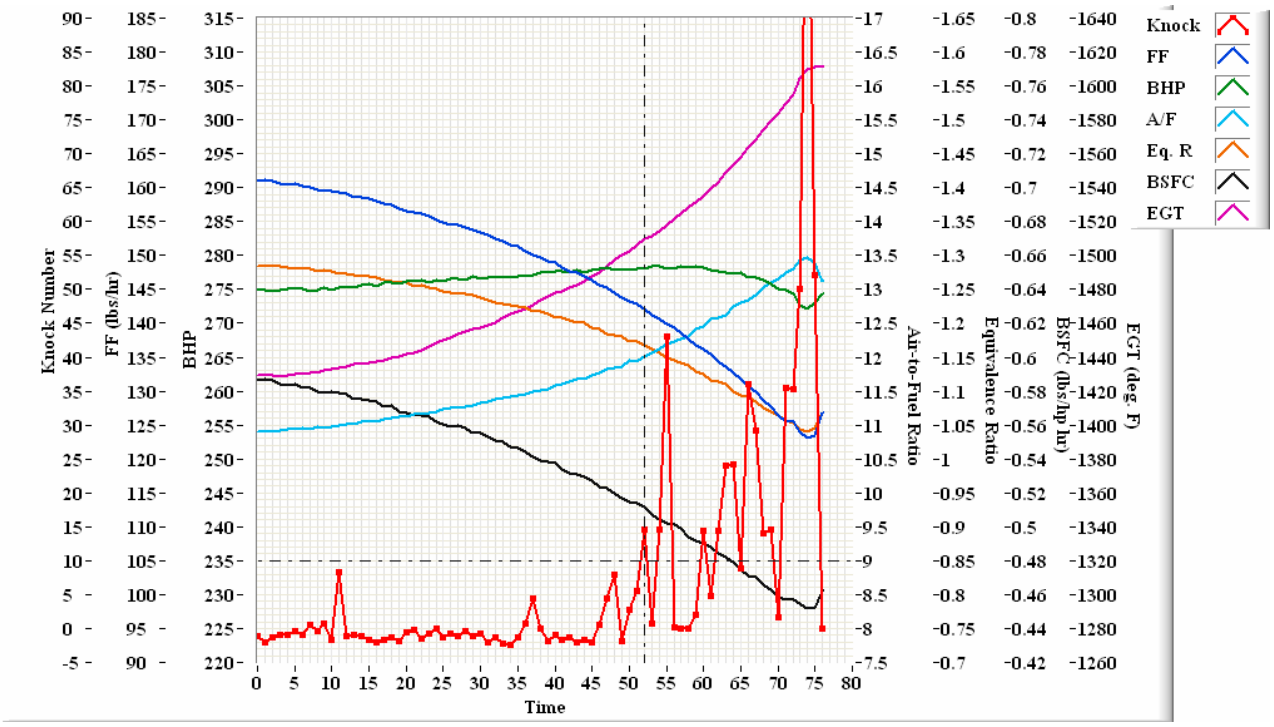


Figure B-61. Blend 17, 2700 rpm

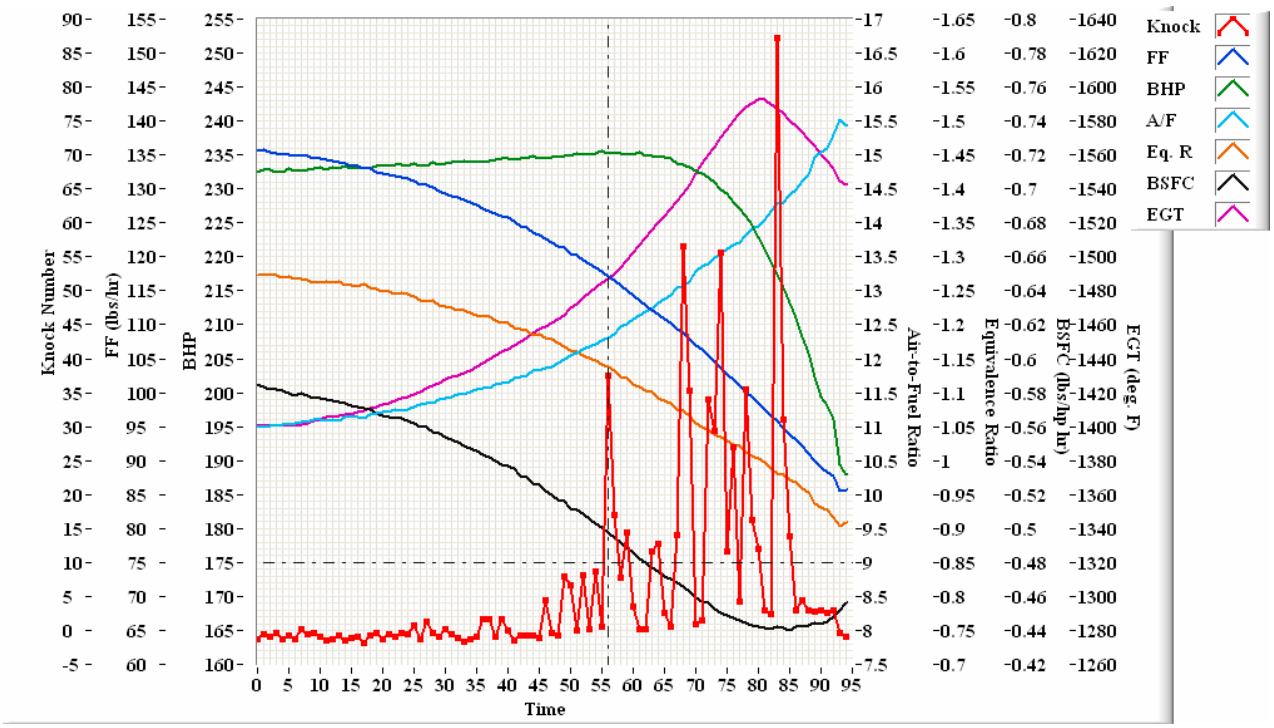


Figure B-62. Blend 17, 2600 rpm

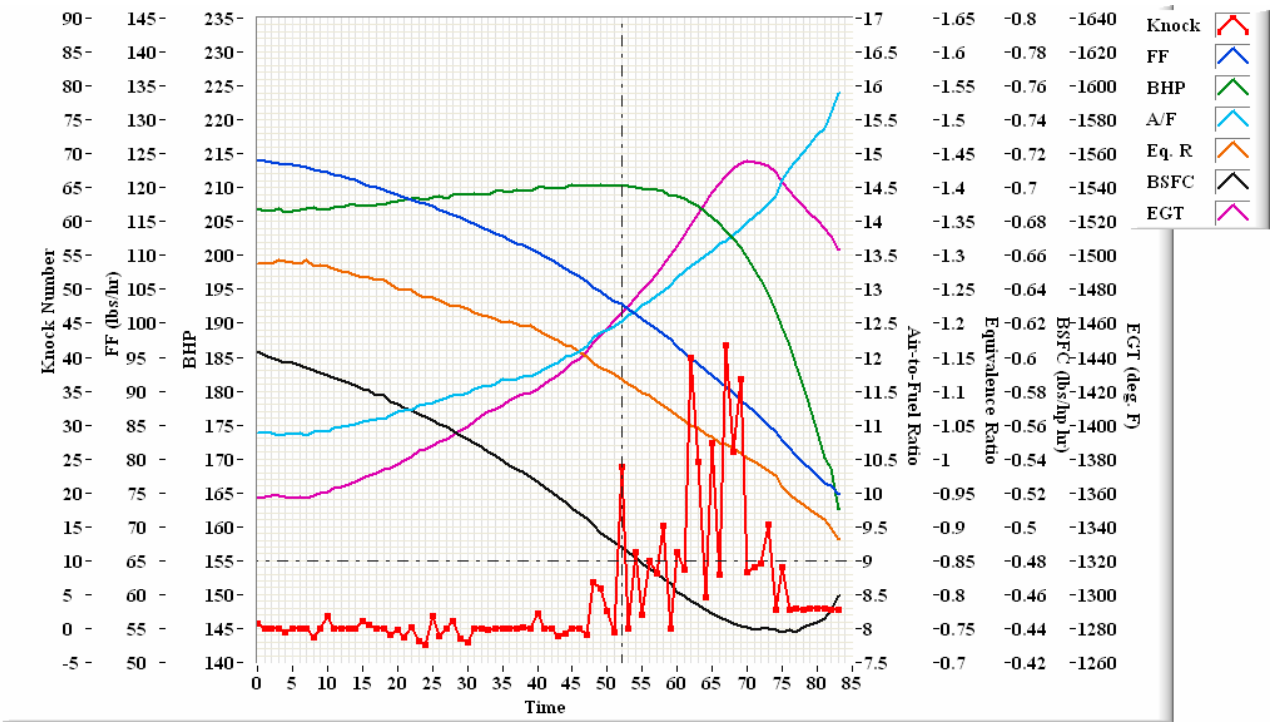


Figure B-63. Blend 17, 2450 rpm

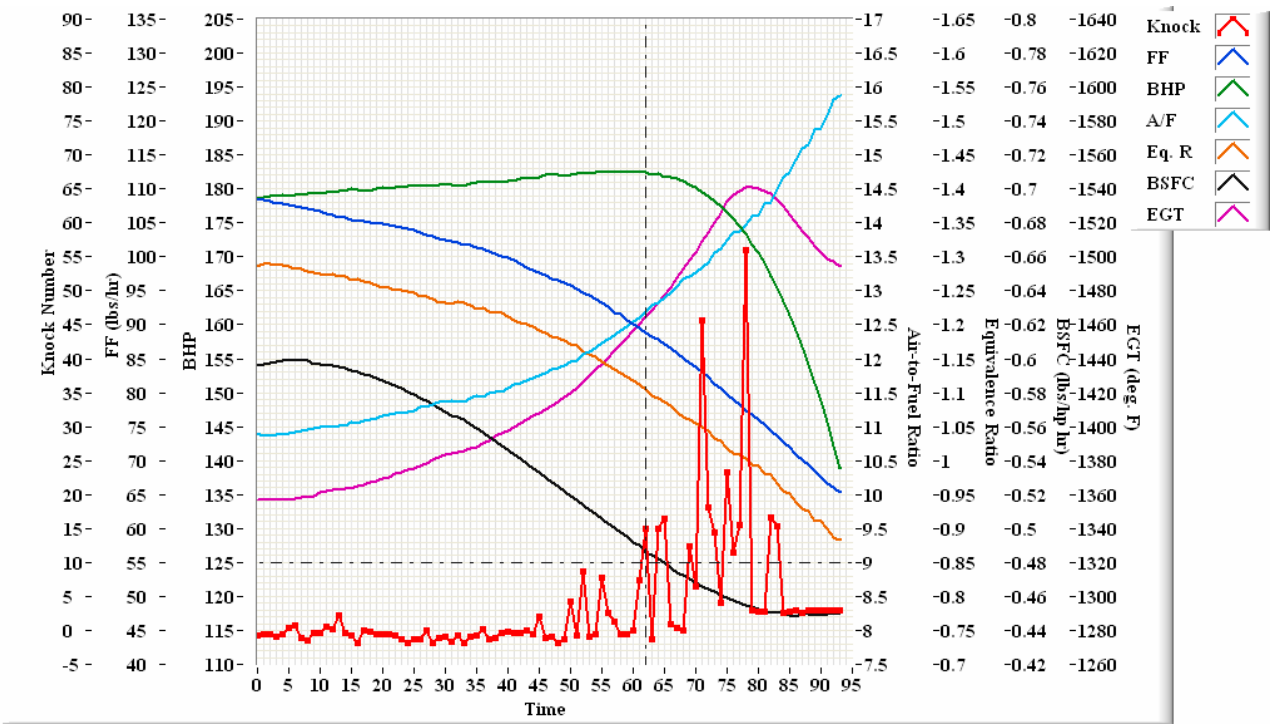


Figure B-64. Blend 17, 2350 rpm

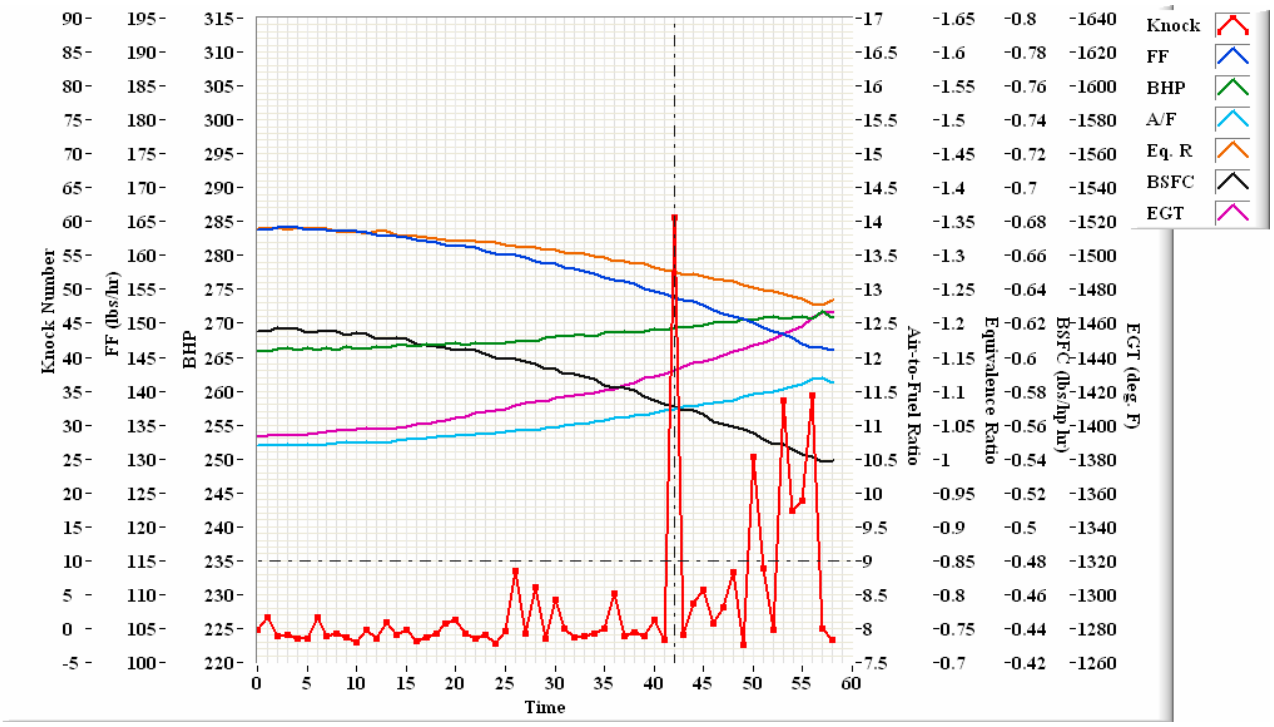


Figure B-65. Blend 18, 2700 rpm

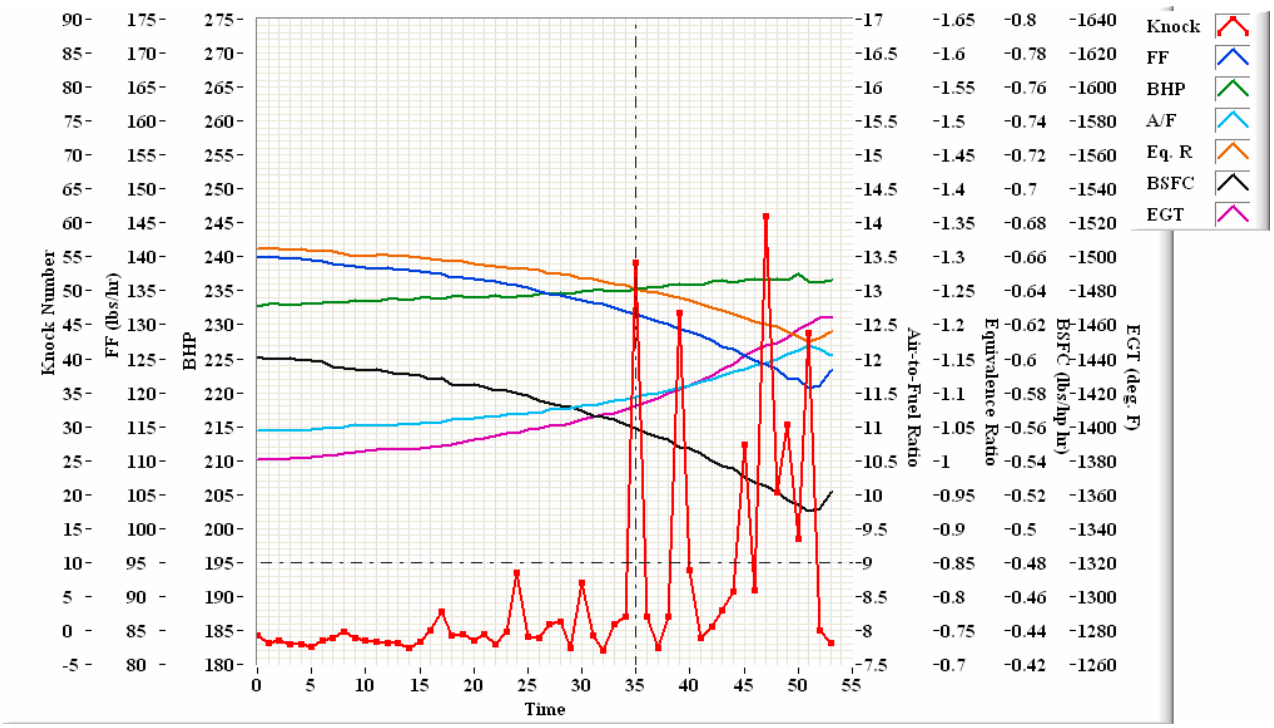


Figure B-66. Blend 18, 2600 rpm

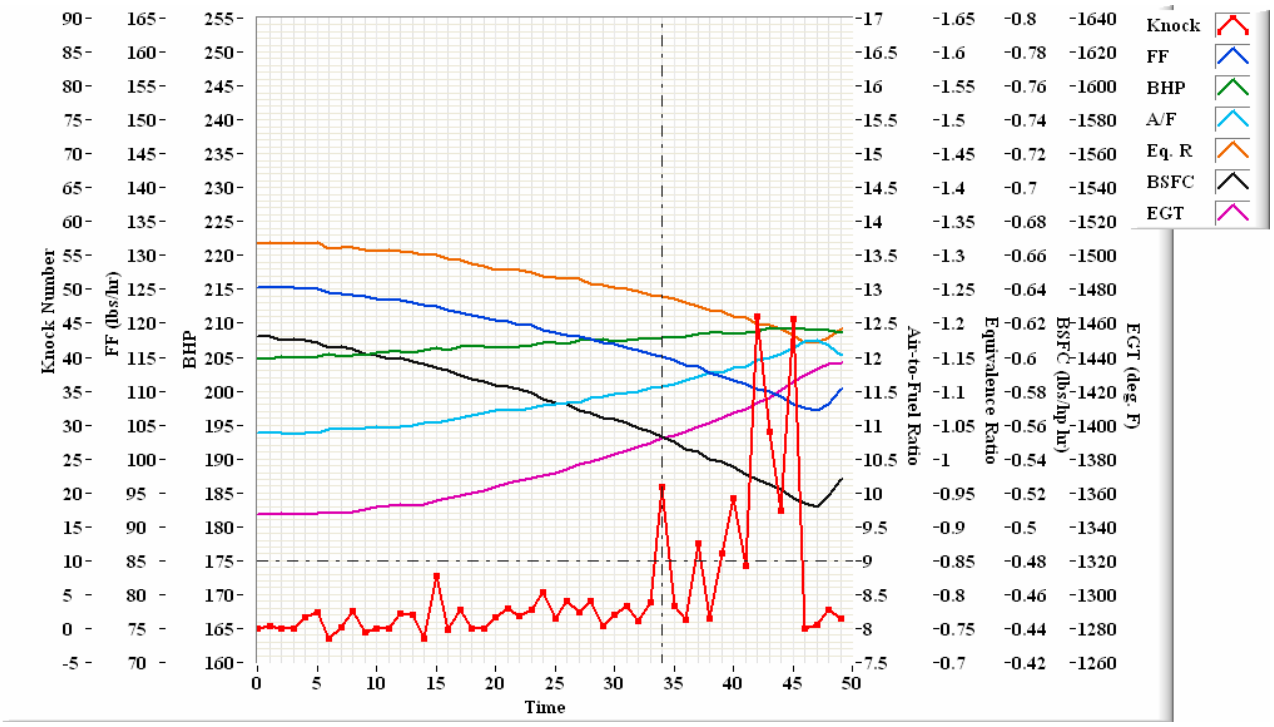


Figure B-67. Blend 18, 2450 rpm

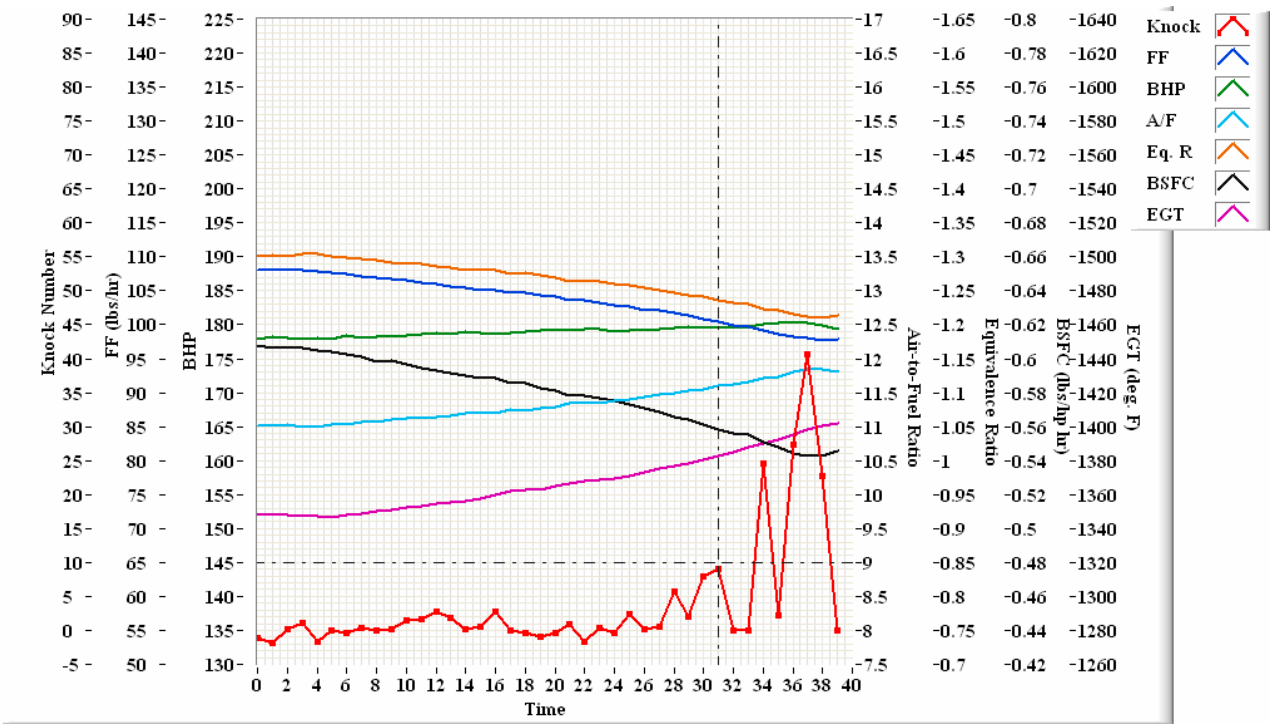


Figure B-68. Blend 18, 2350 rpm

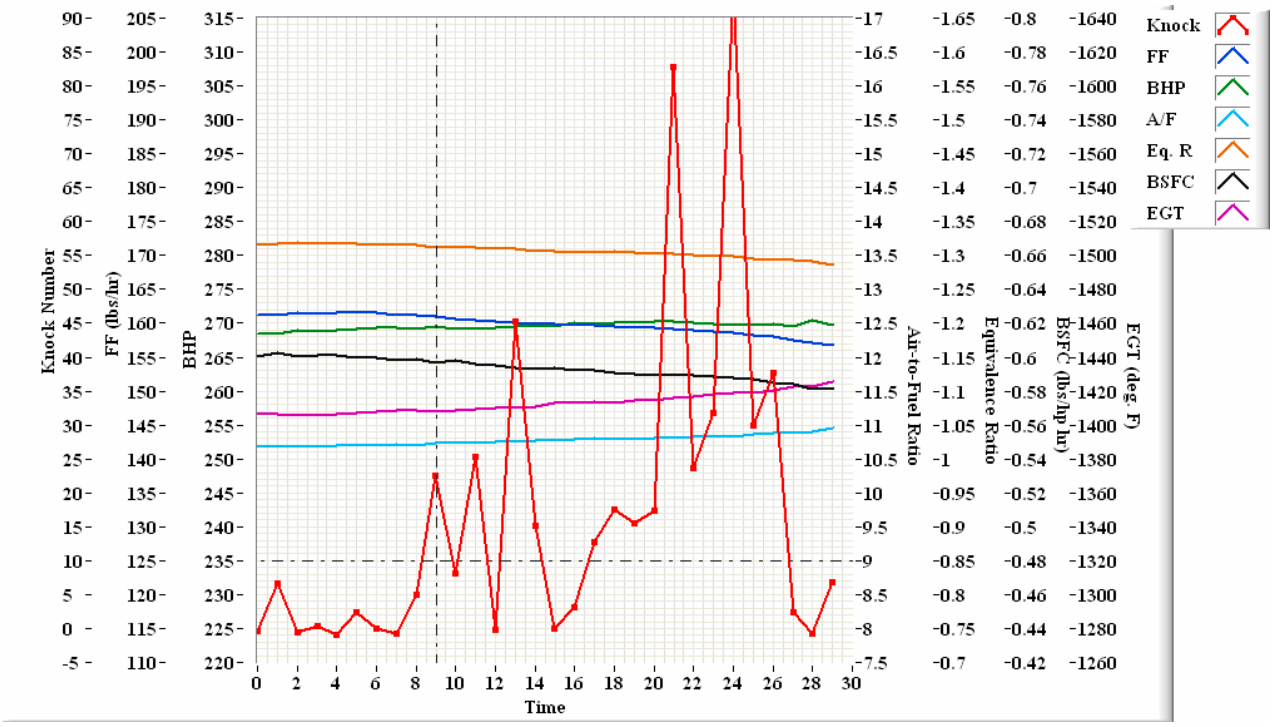


Figure B-69. Blend 19, 2700 rpm

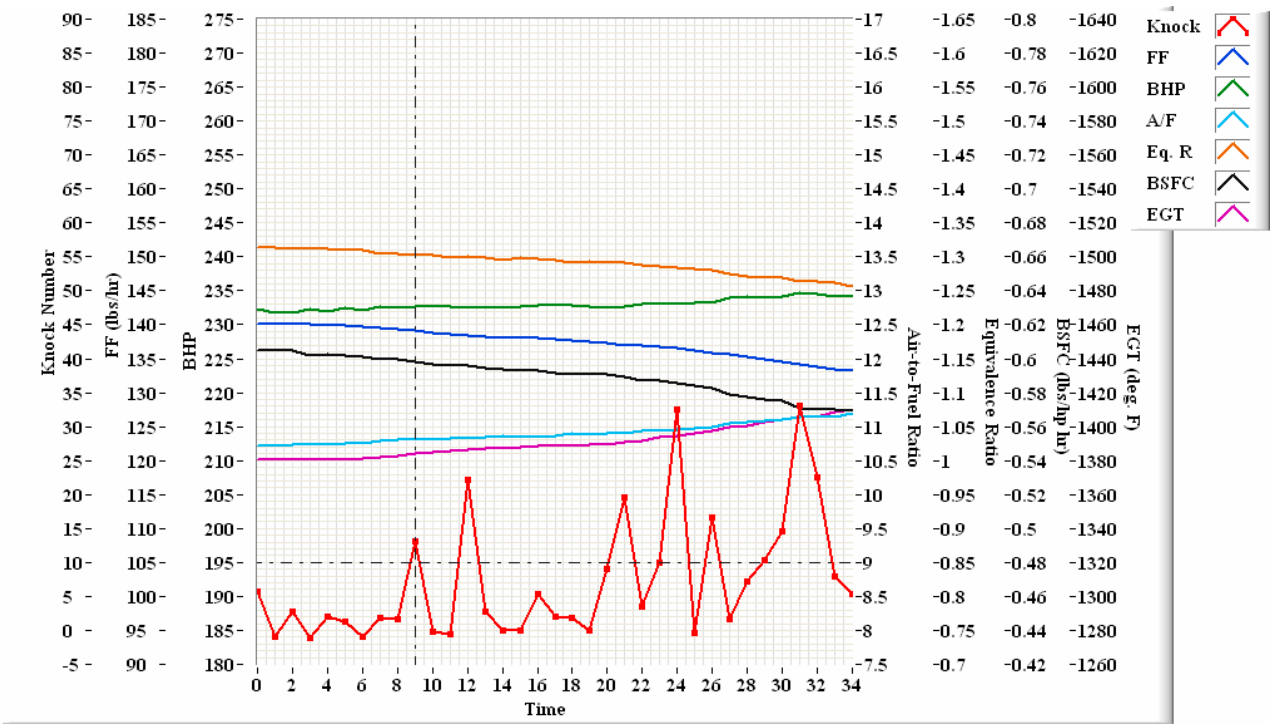


Figure B-70. Blend 19, 2600 rpm

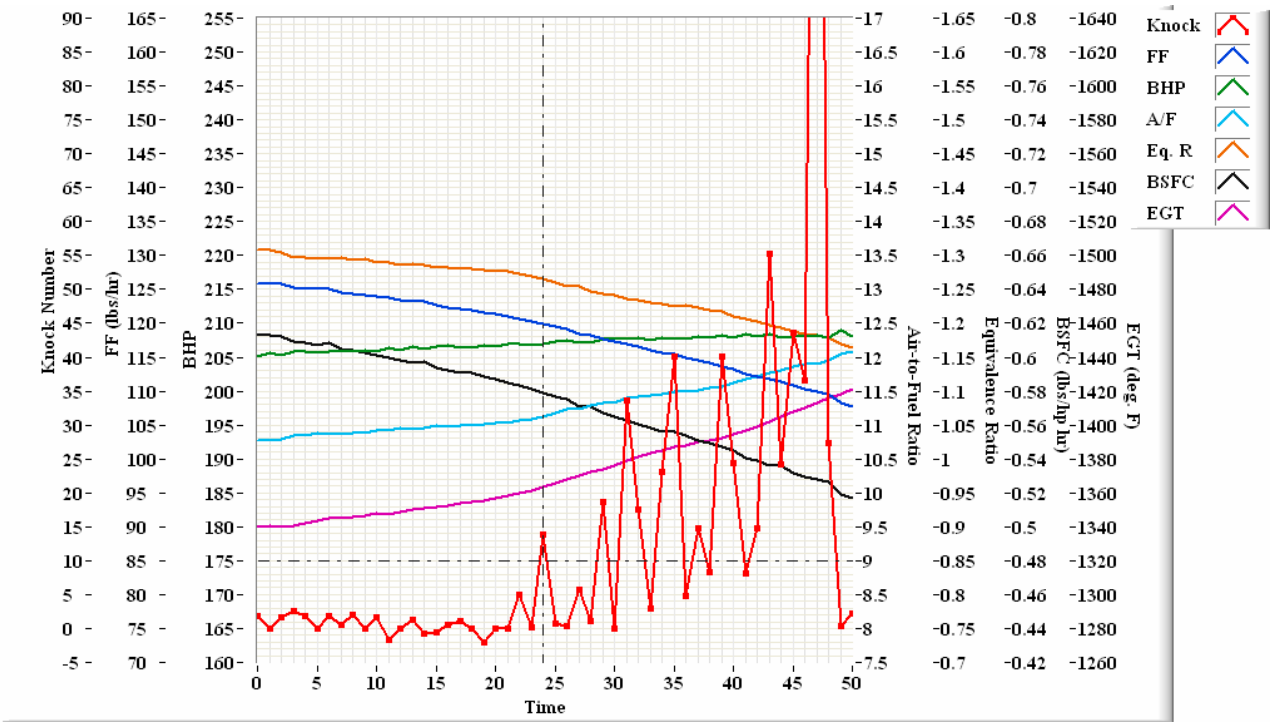


Figure B-71. Blend 19, 2450 rpm

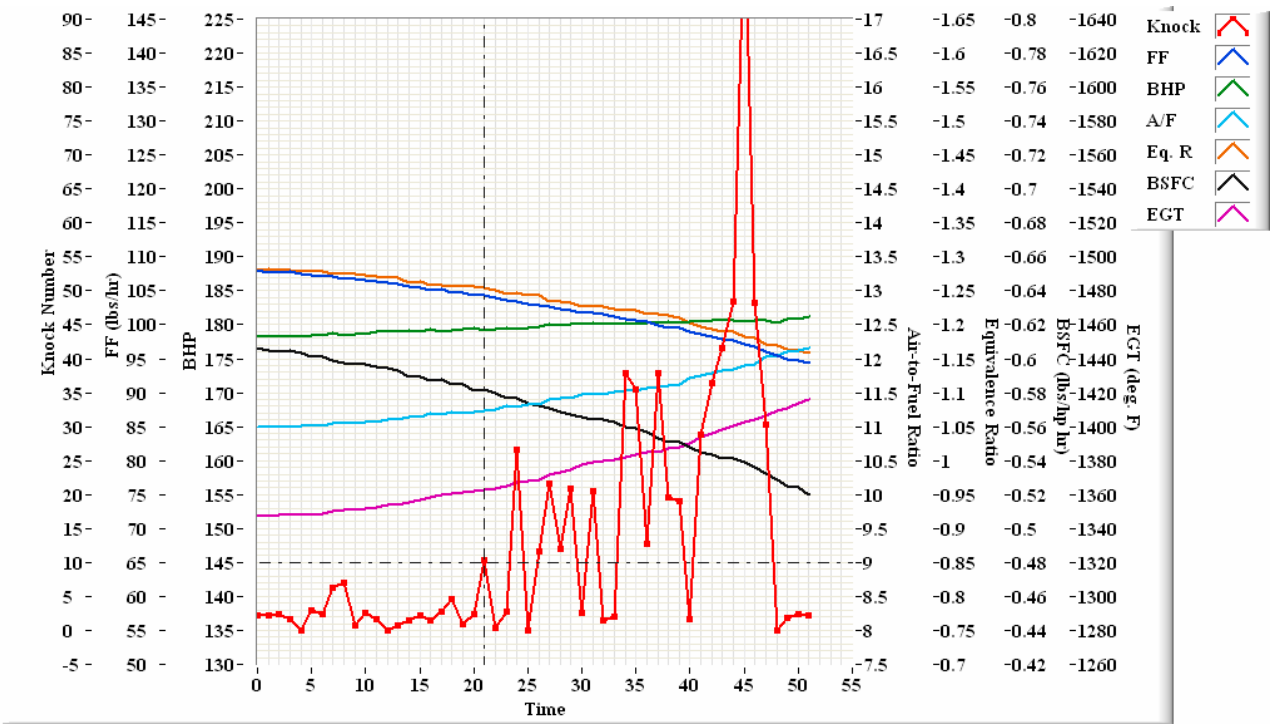


Figure B-72. Blend 19, 2350 rpm

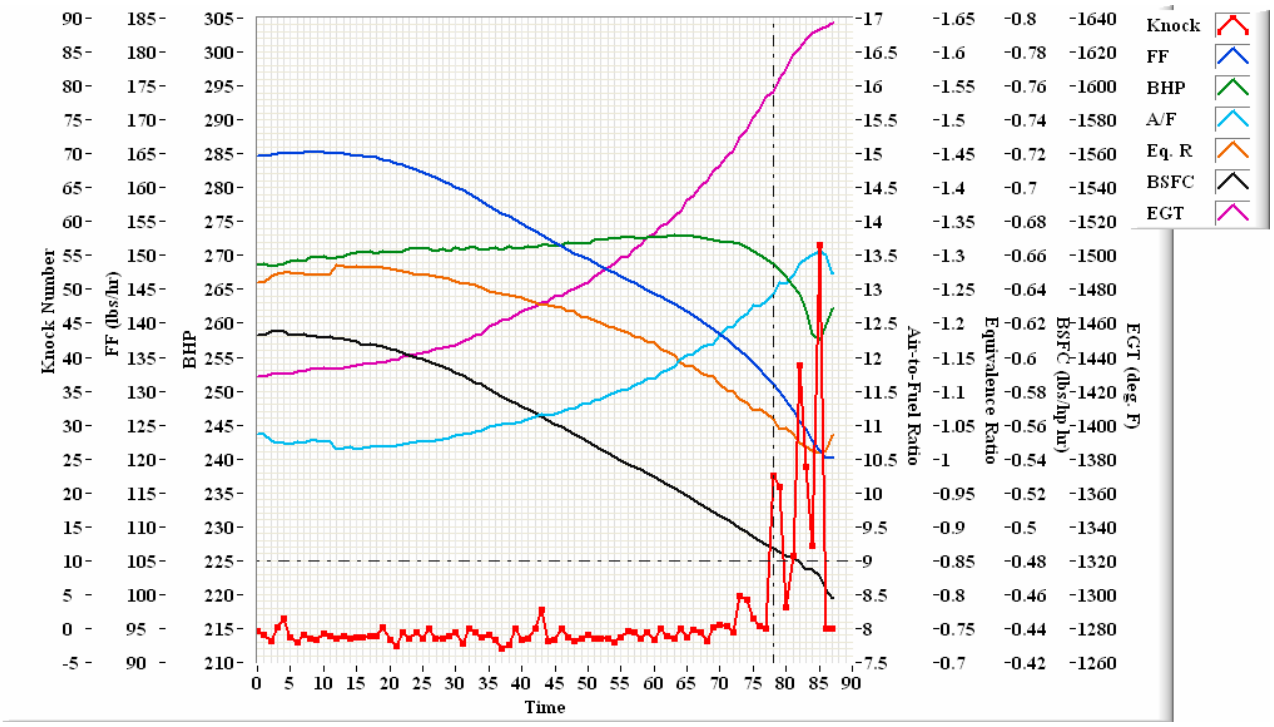


Figure B-73. Blend 20, 2700 rpm

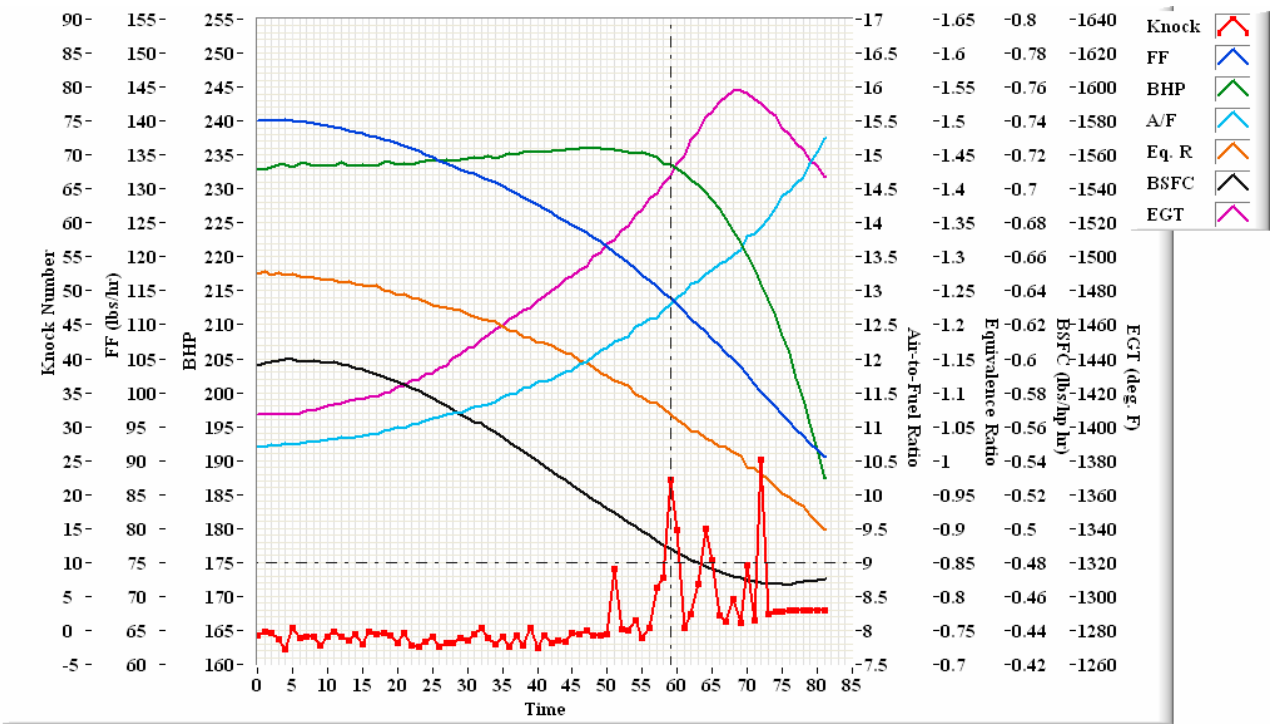


Figure B-74. Blend 20, 2600 rpm

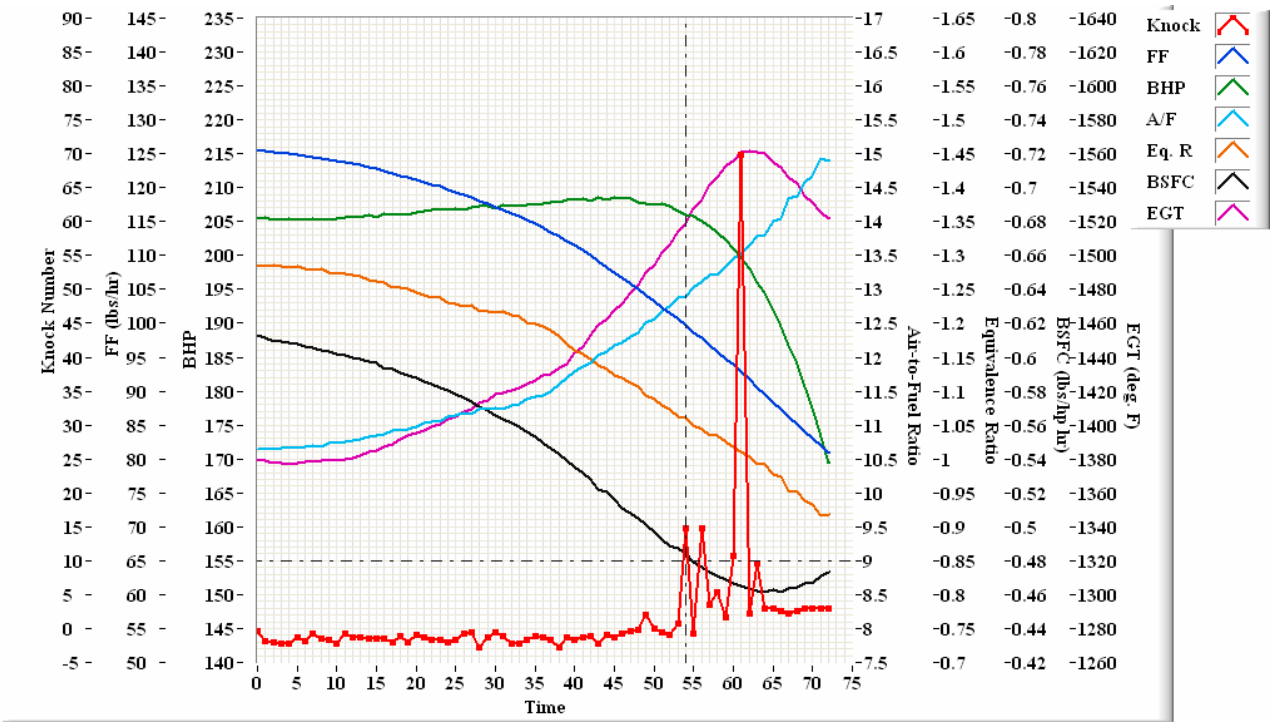


Figure B-75. Blend 20, 2450 rpm

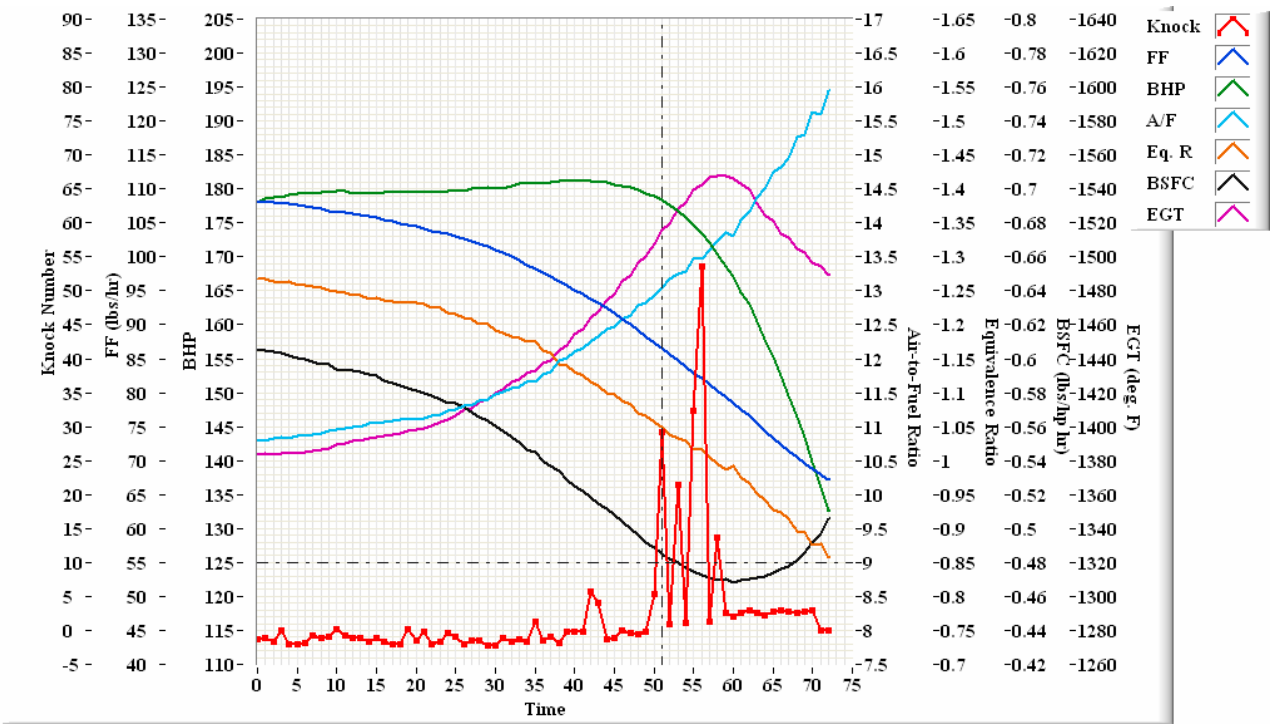


Figure B-76. Blend 20, 2350 rpm

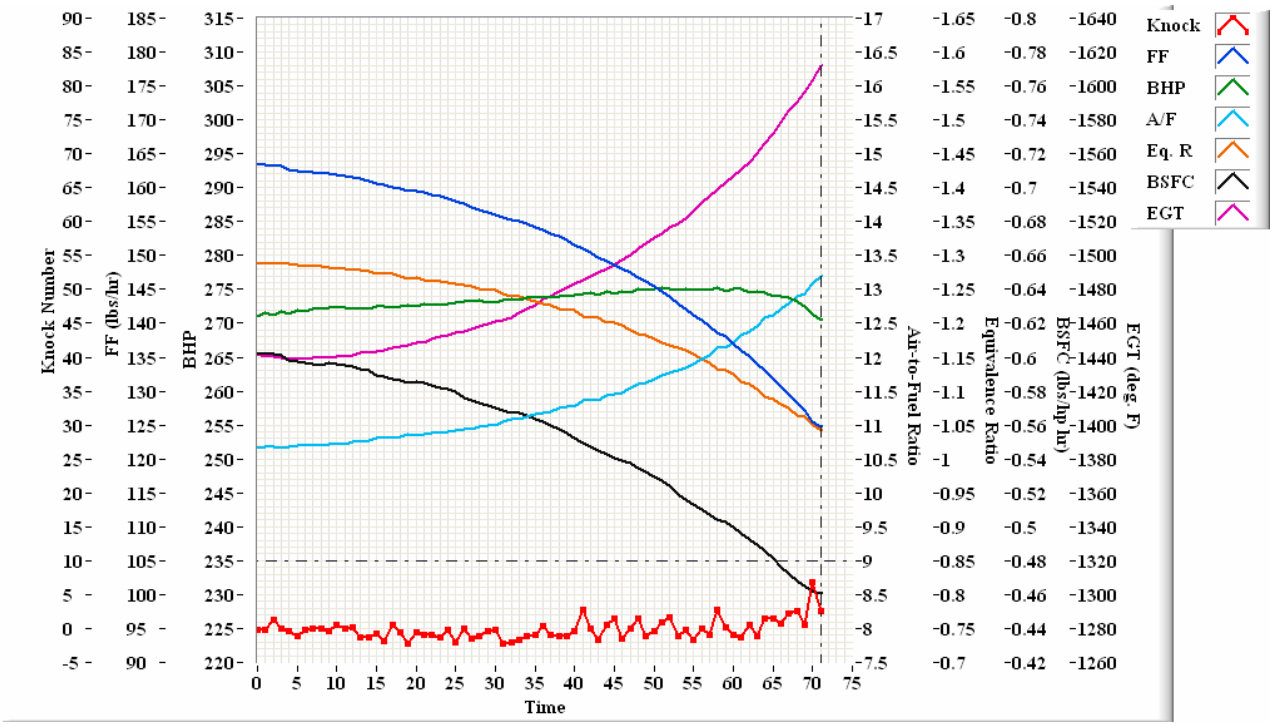


Figure B-77. Blend 21, 2700 rpm

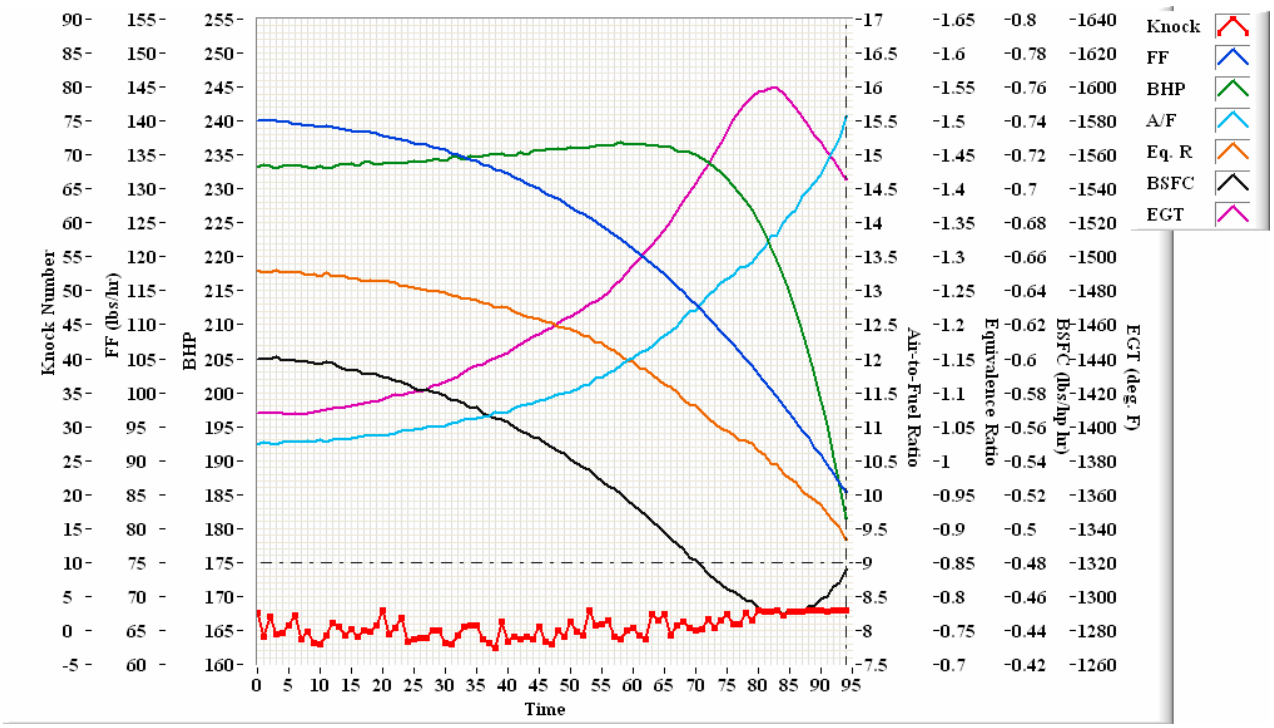


Figure B-78. Blend 21, 2600 rpm

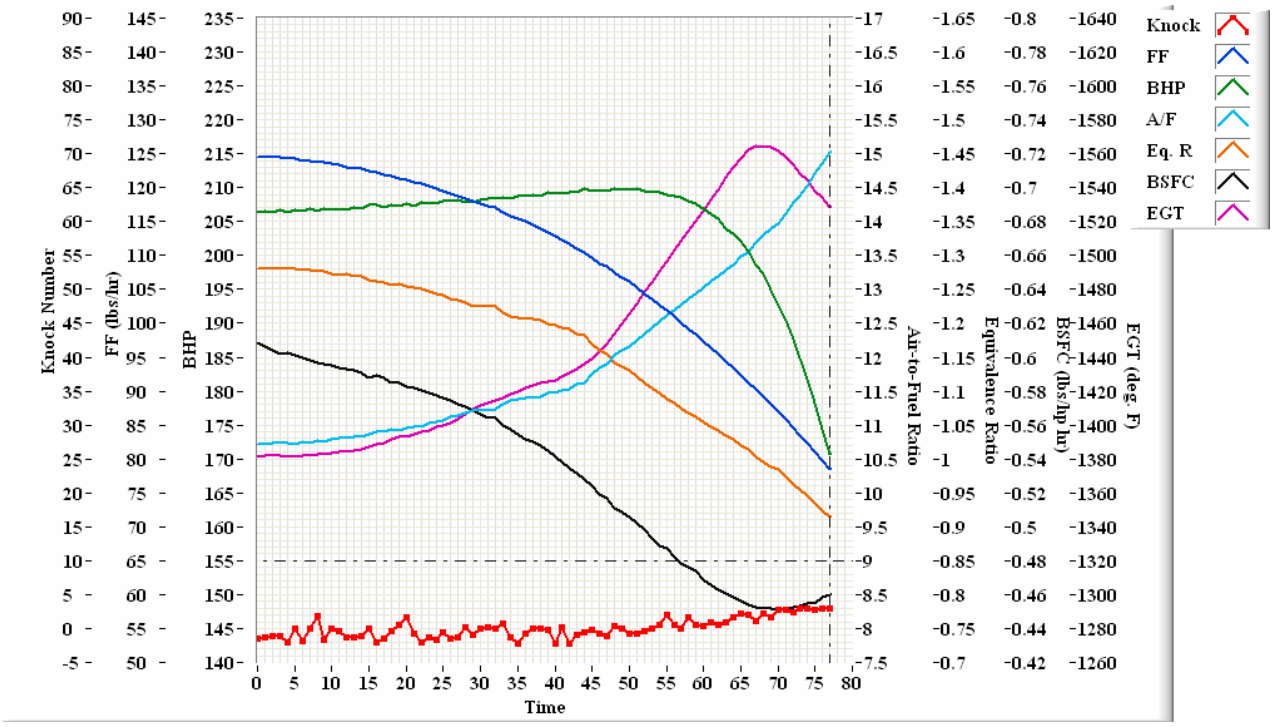


Figure B-79. Blend 21, 2450 rpm

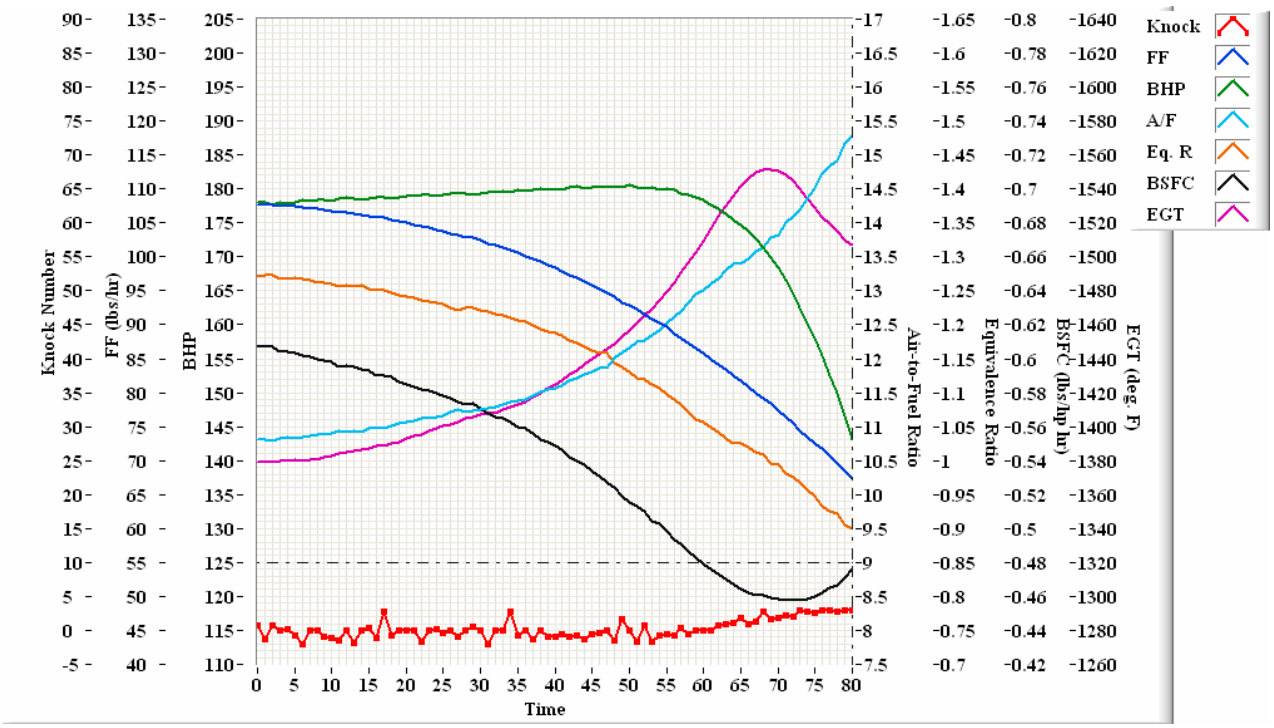


Figure B-80. Blend 21, 2350 rpm

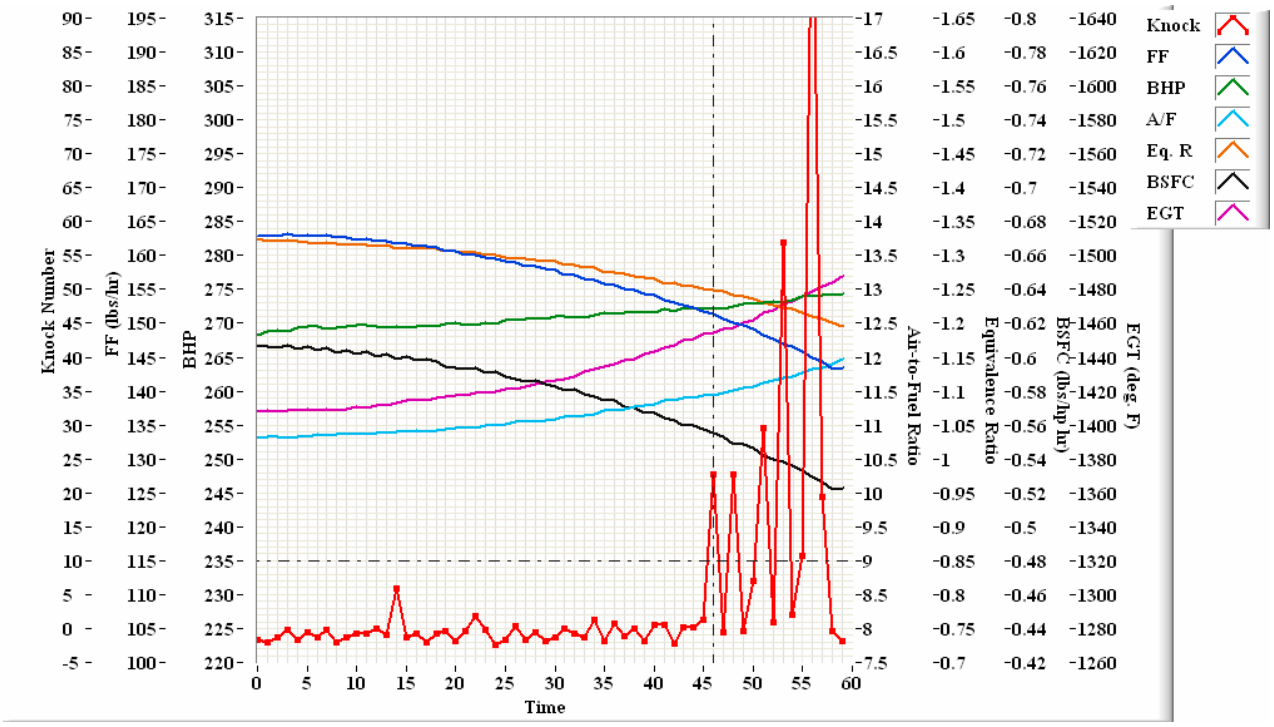


Figure B-81. Blend 22, 2700 rpm

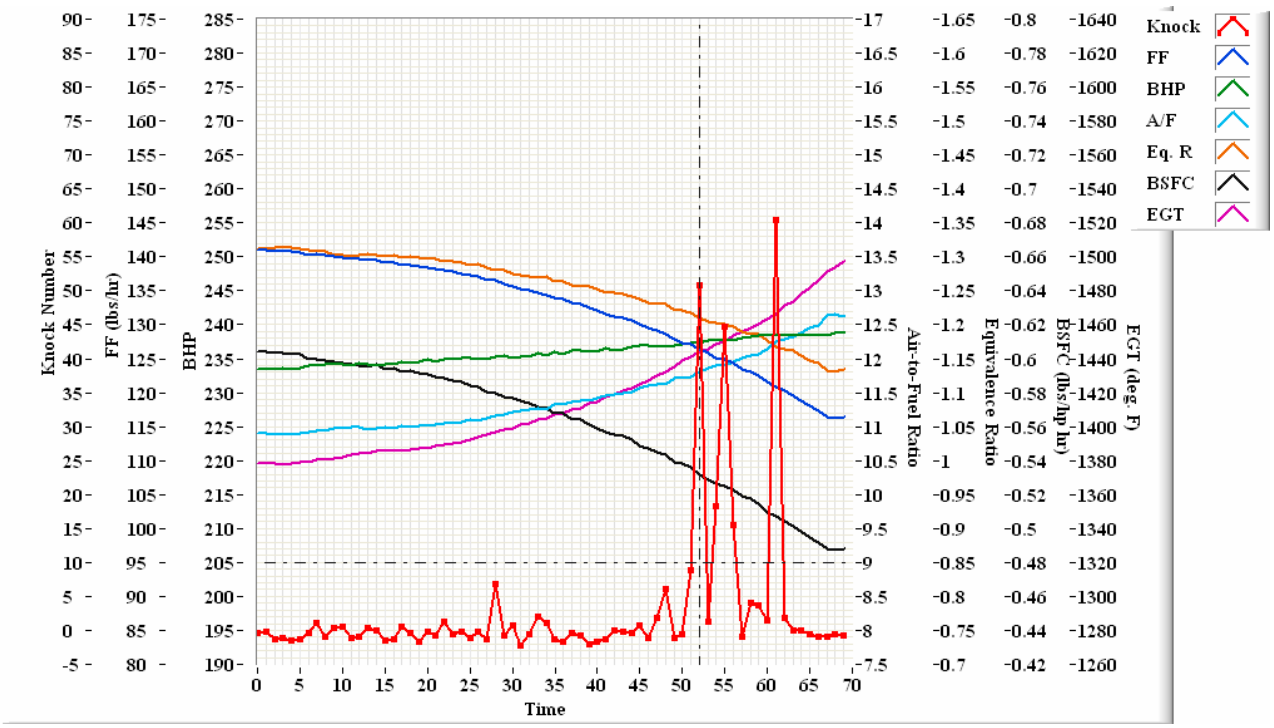


Figure B-82. Blend 22, 2600 rpm

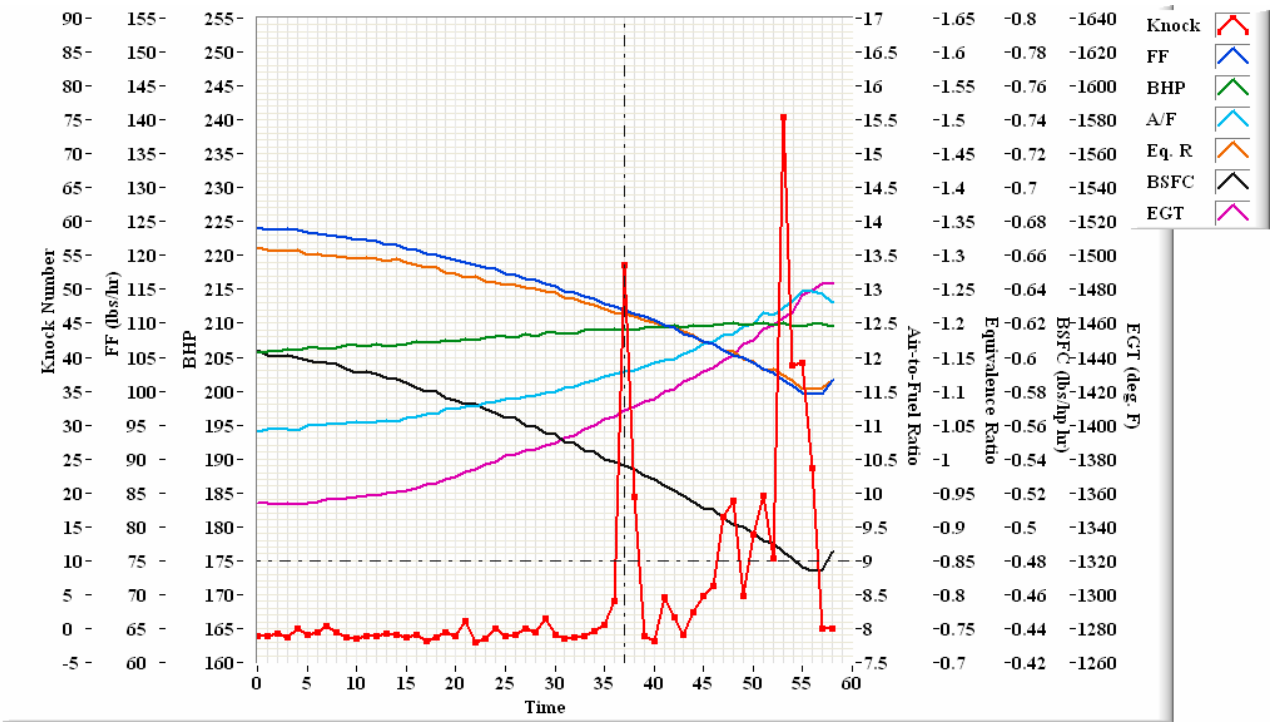


Figure B-83. Blend 22, 2450 rpm

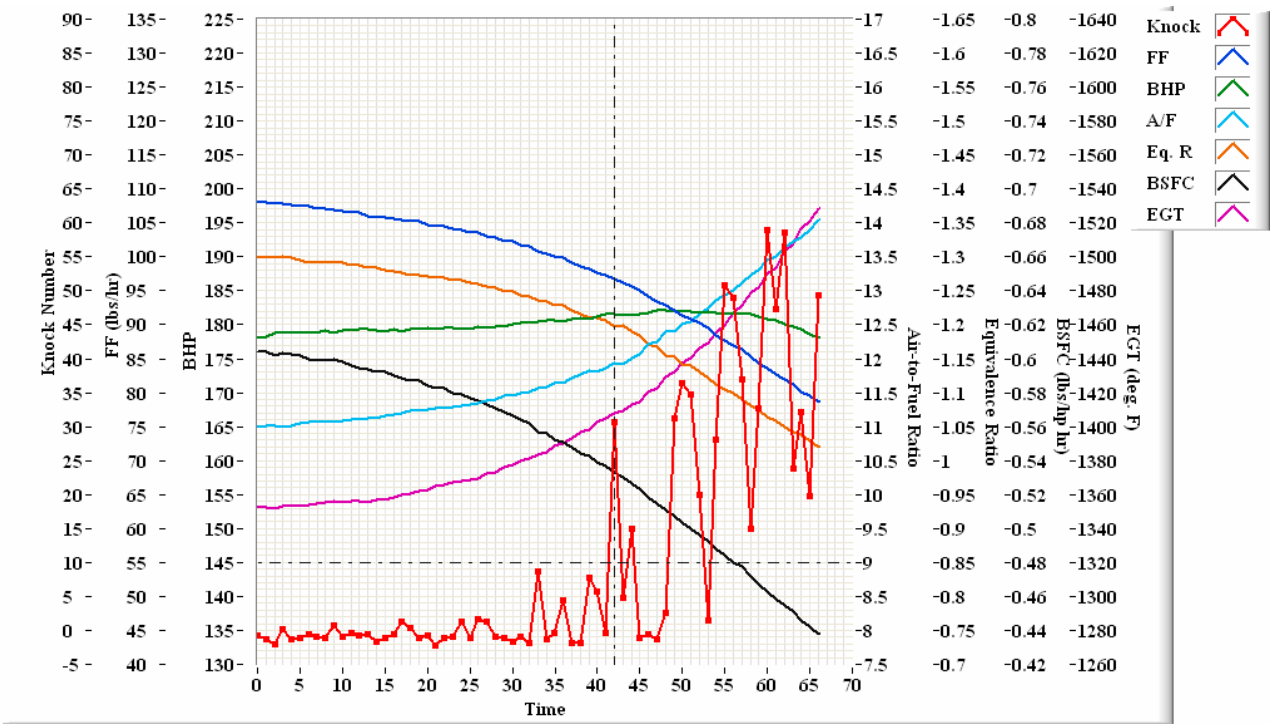


Figure B-84. Blend 22, 2350 rpm

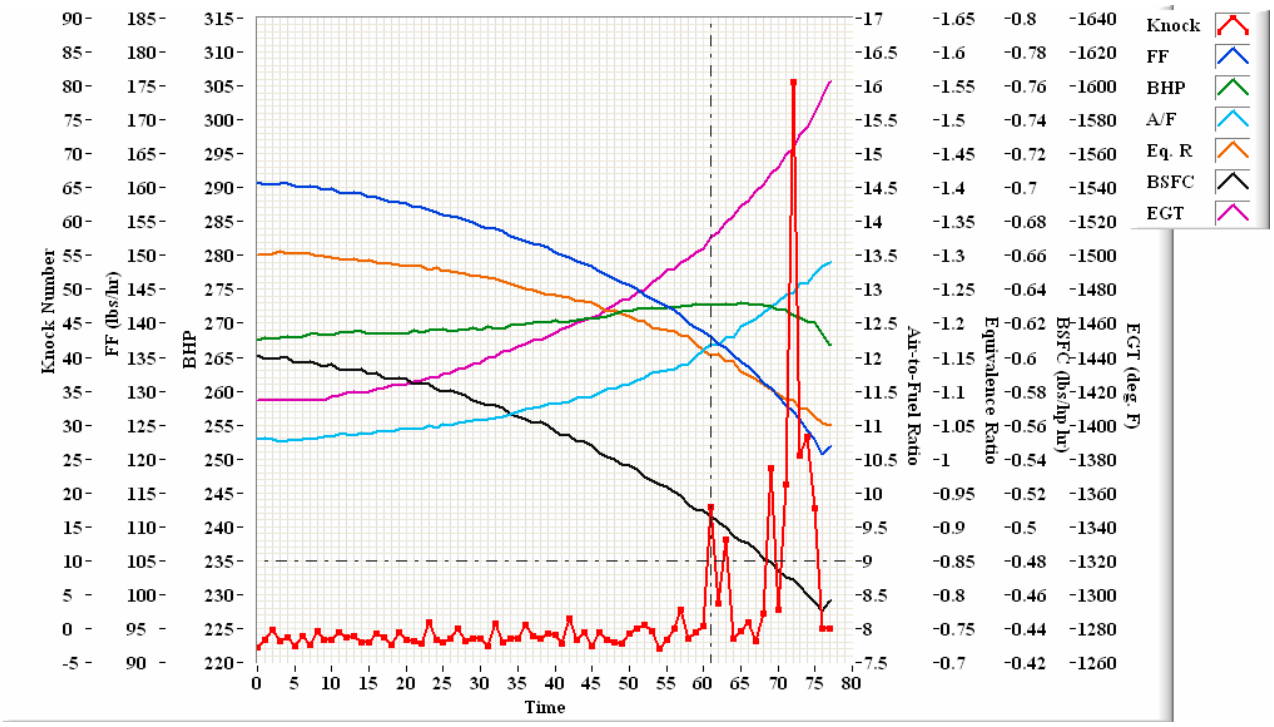


Figure B-85. Blend 23, 2700 rpm

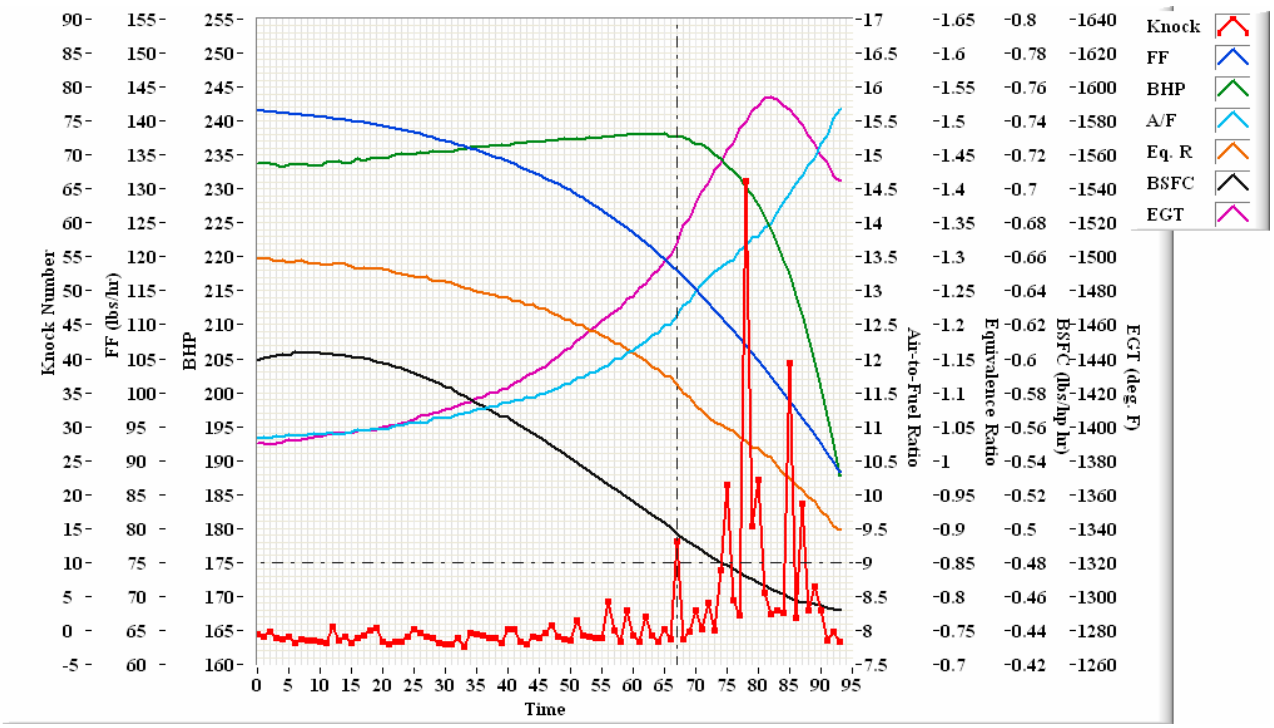


Figure B-86. Blend 23, 2600 rpm

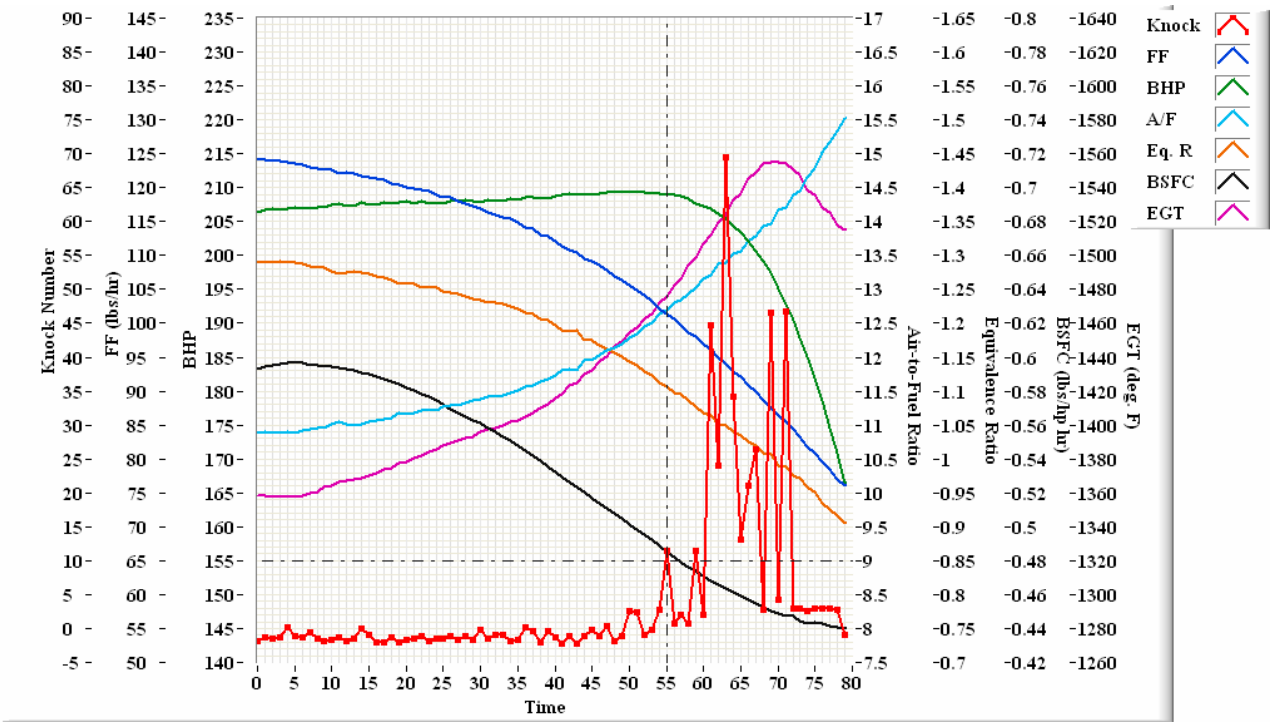


Figure B-87. Blend 23, 2450 rpm

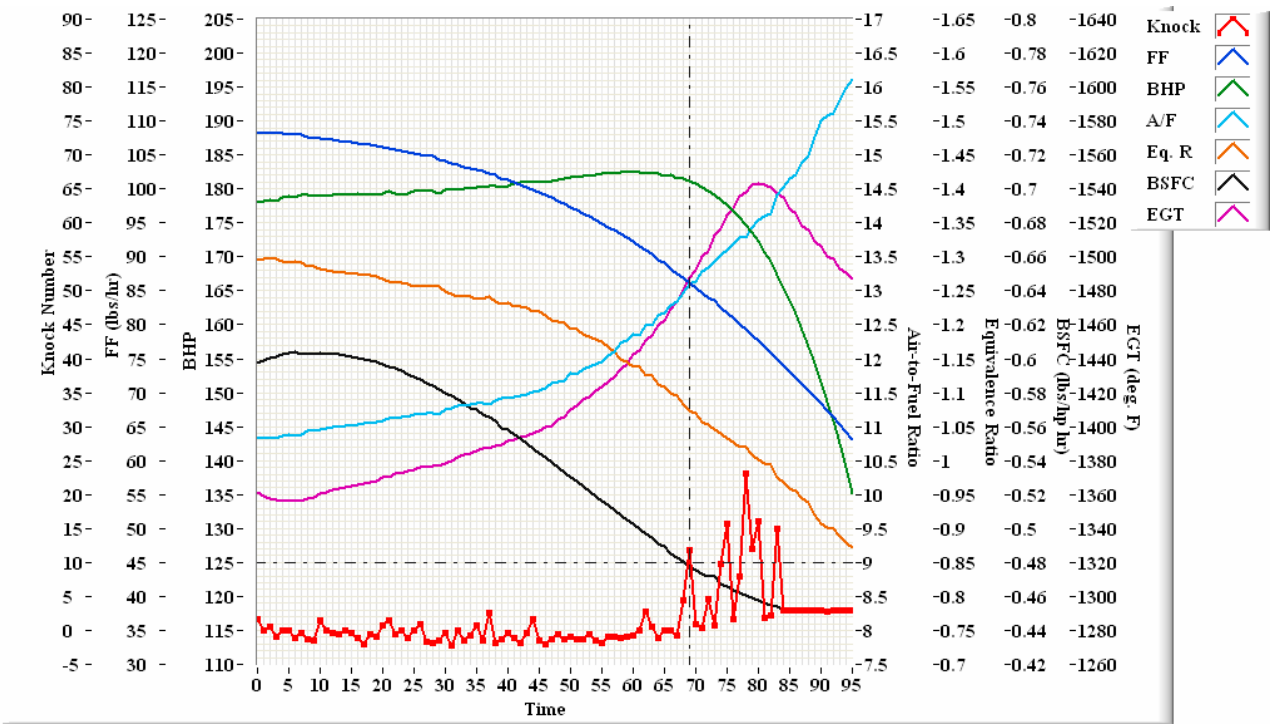


Figure B-88. Blend 23, 2350 rpm

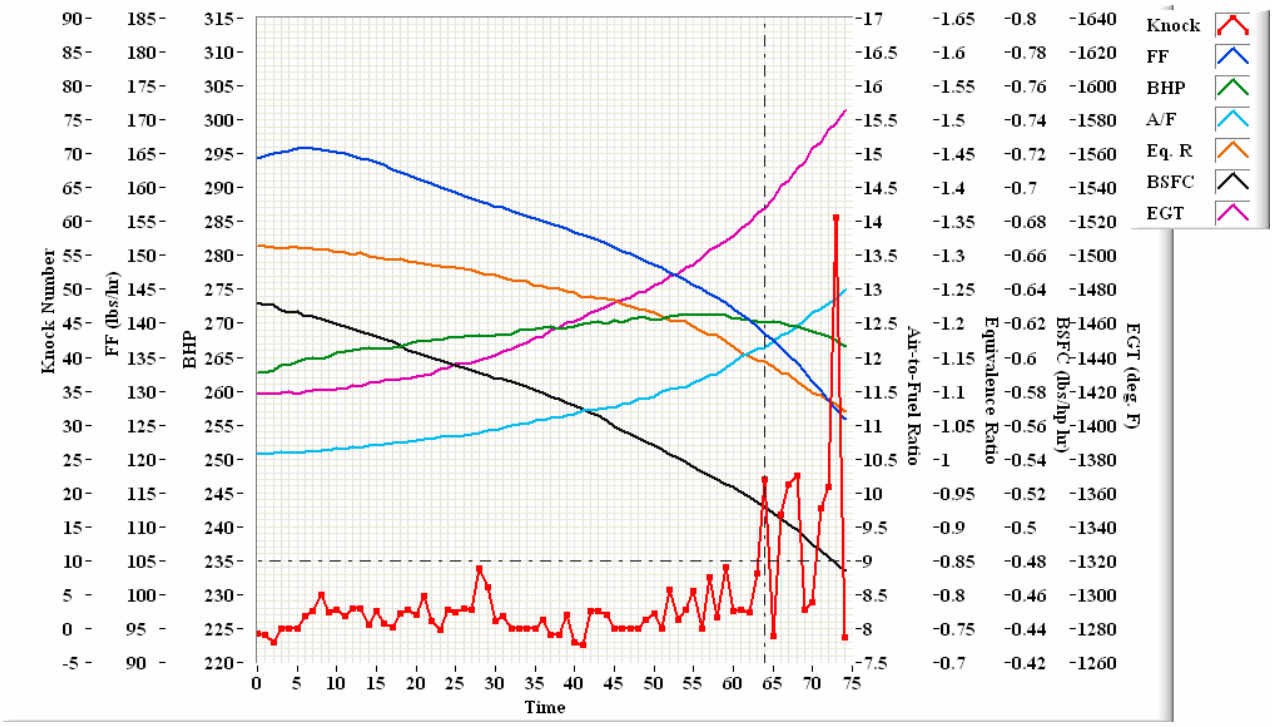


Figure B-89. Blend 24, 2700 rpm

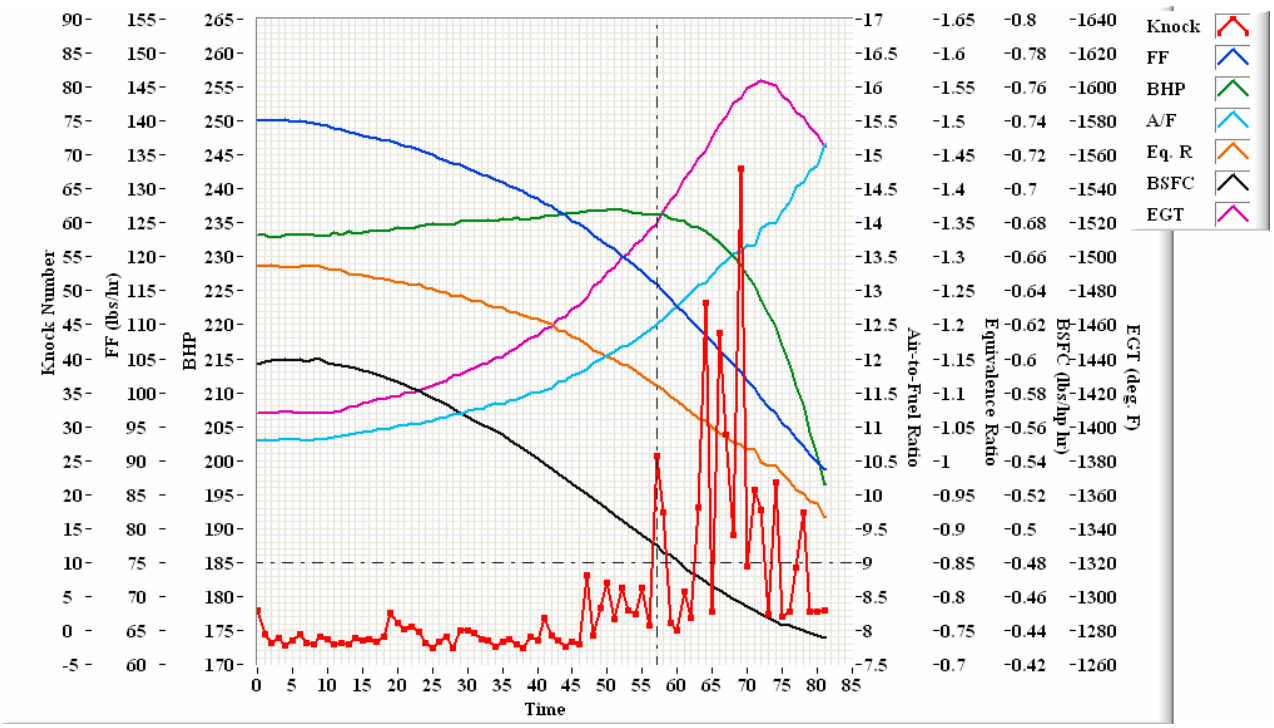


Figure B-90. Blend 24, 2600 rpm

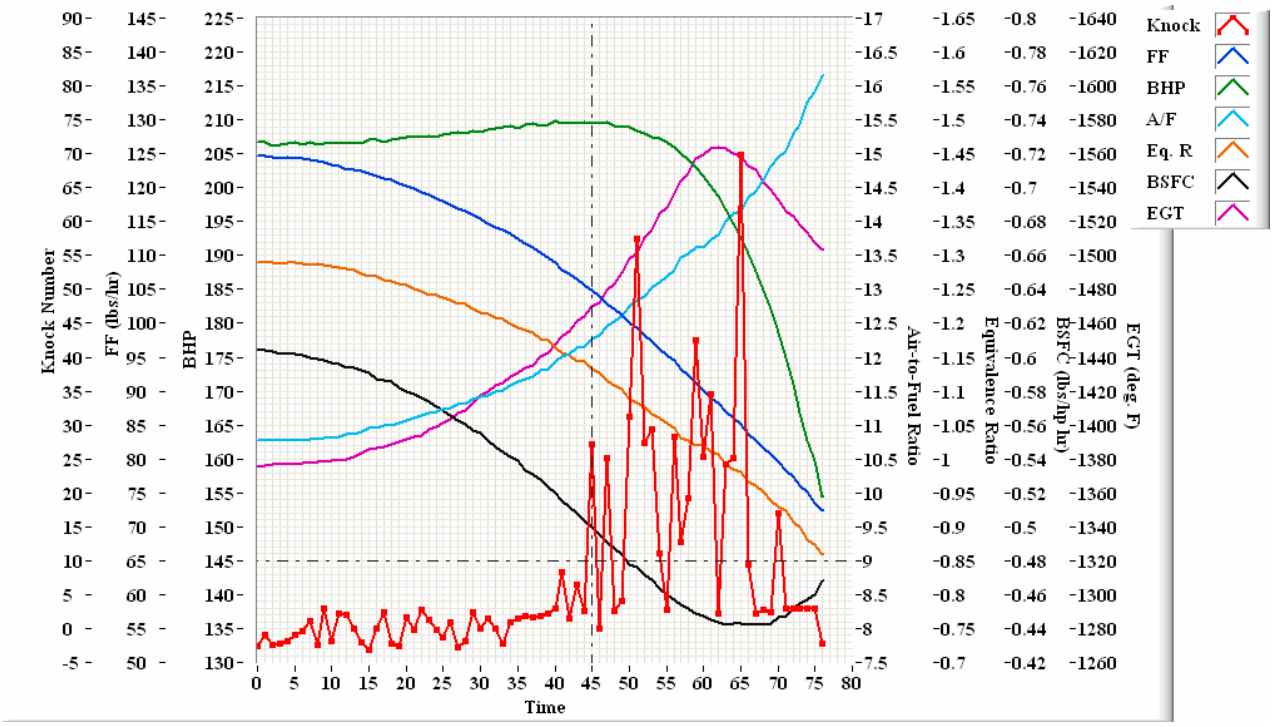


Figure B-91. Blend 24, 2450 rpm

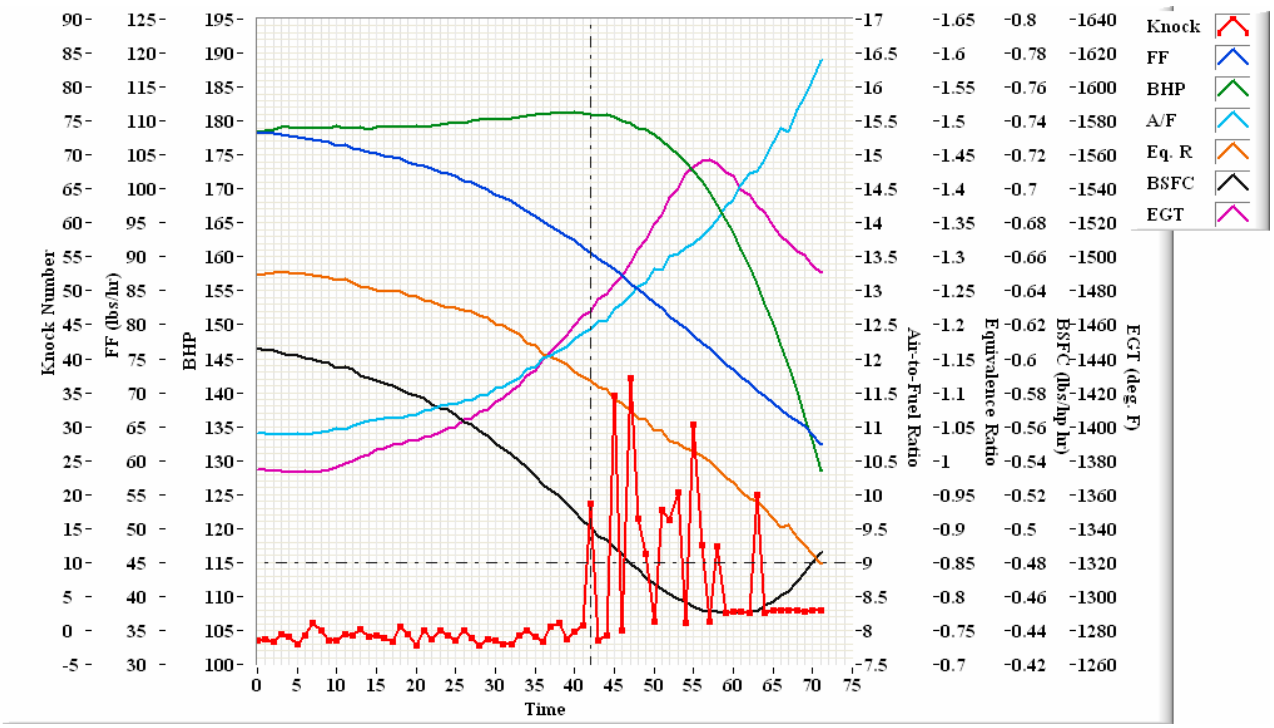


Figure B-92. Blend 24, 2350 rpm

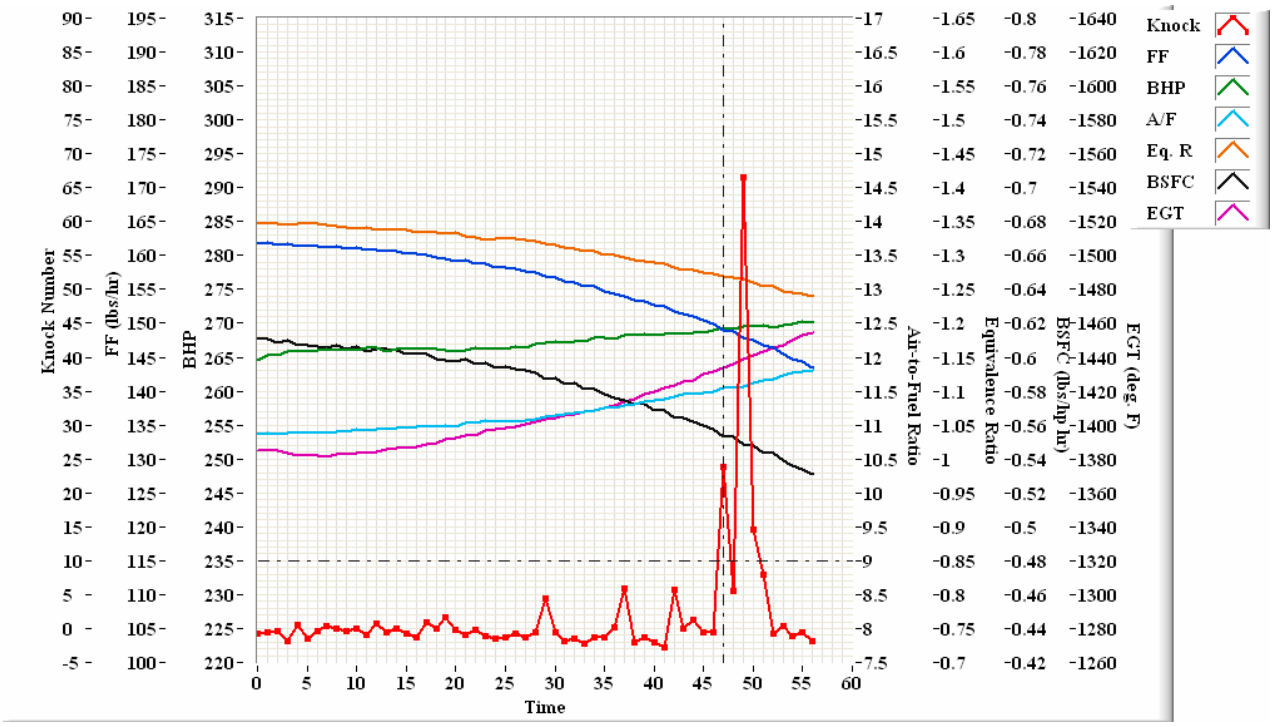


Figure B-93. Blend 25, 2700 rpm

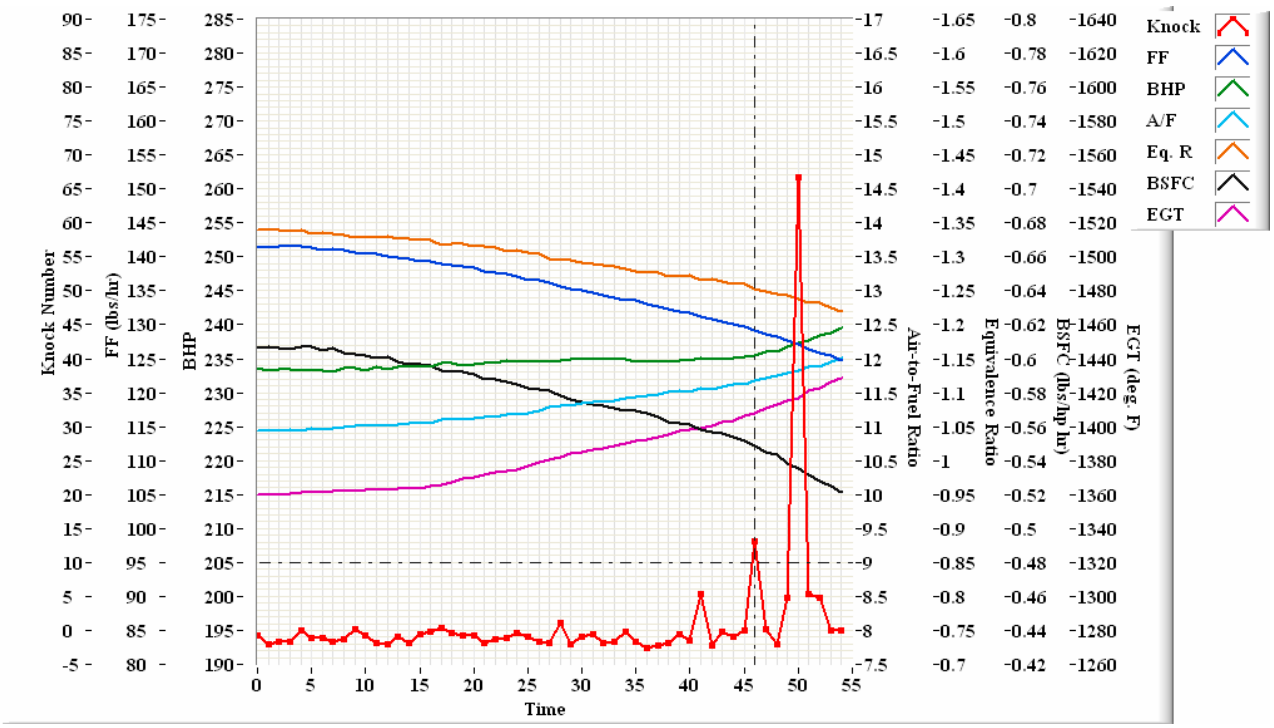


Figure B-94. Blend 25, 2600 rpm

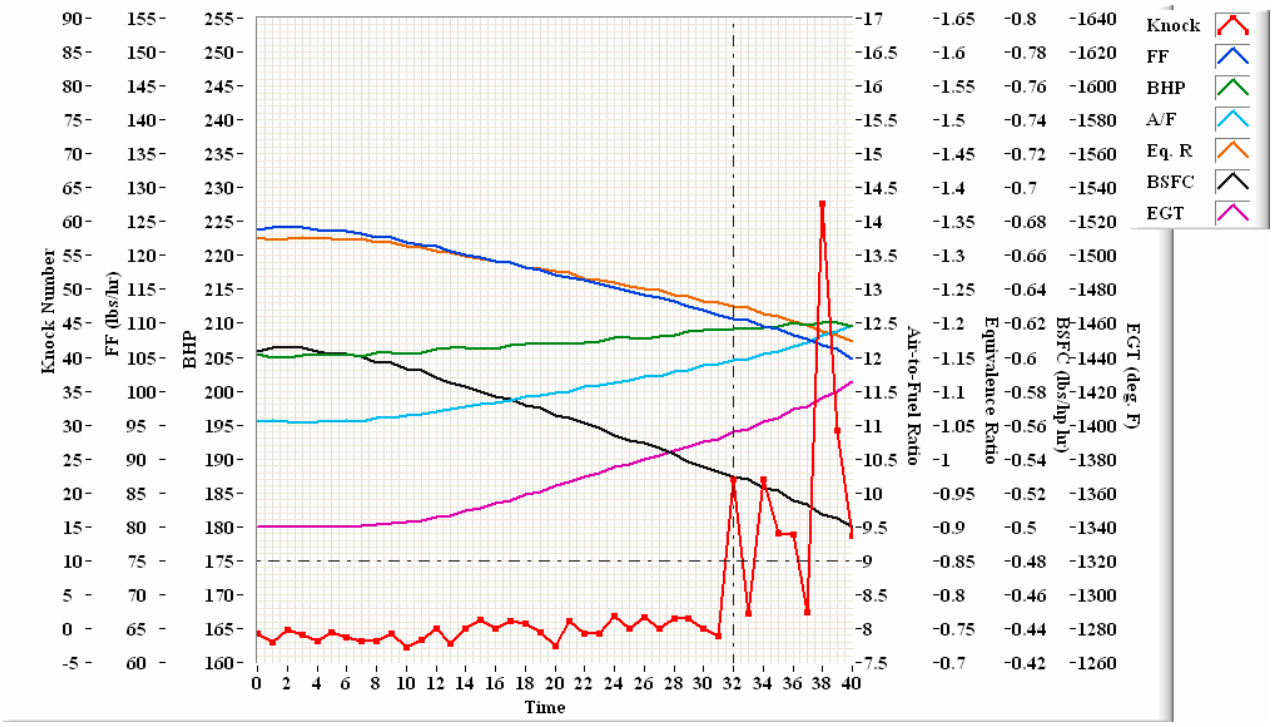


Figure B-95. Blend 25, 2450 rpm

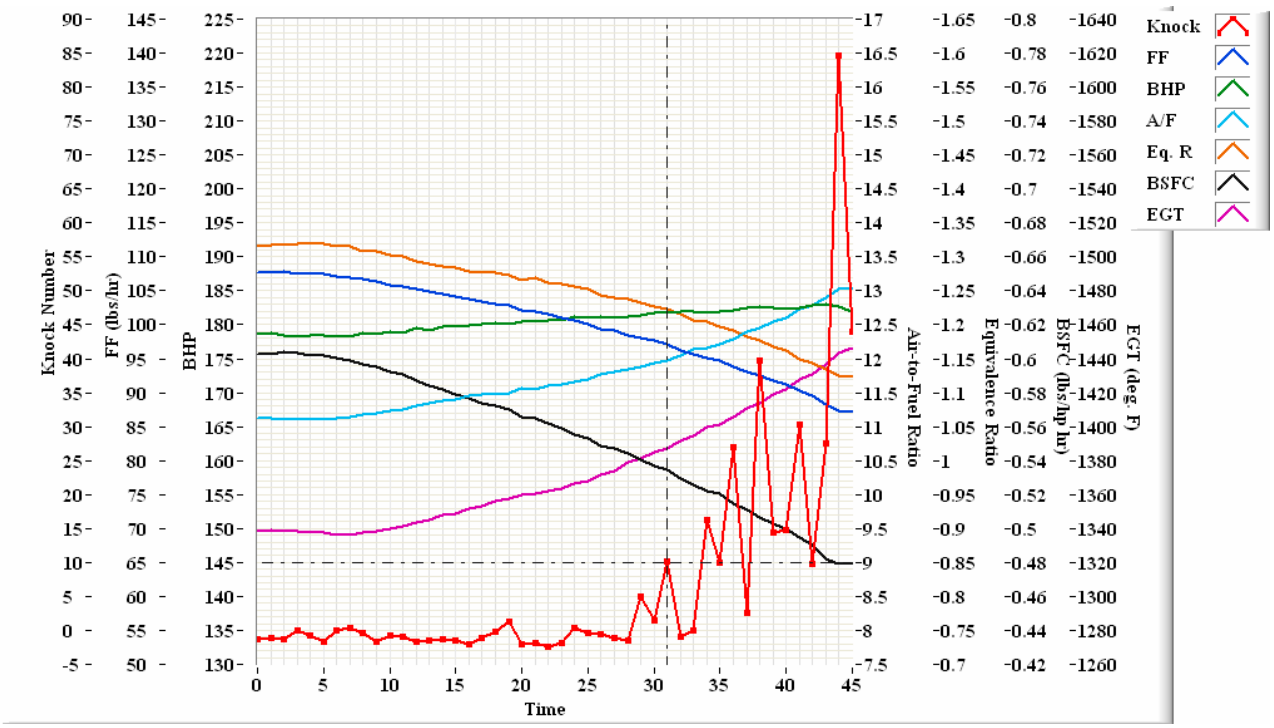


Figure B-96. Blend 25, 2350 rpm

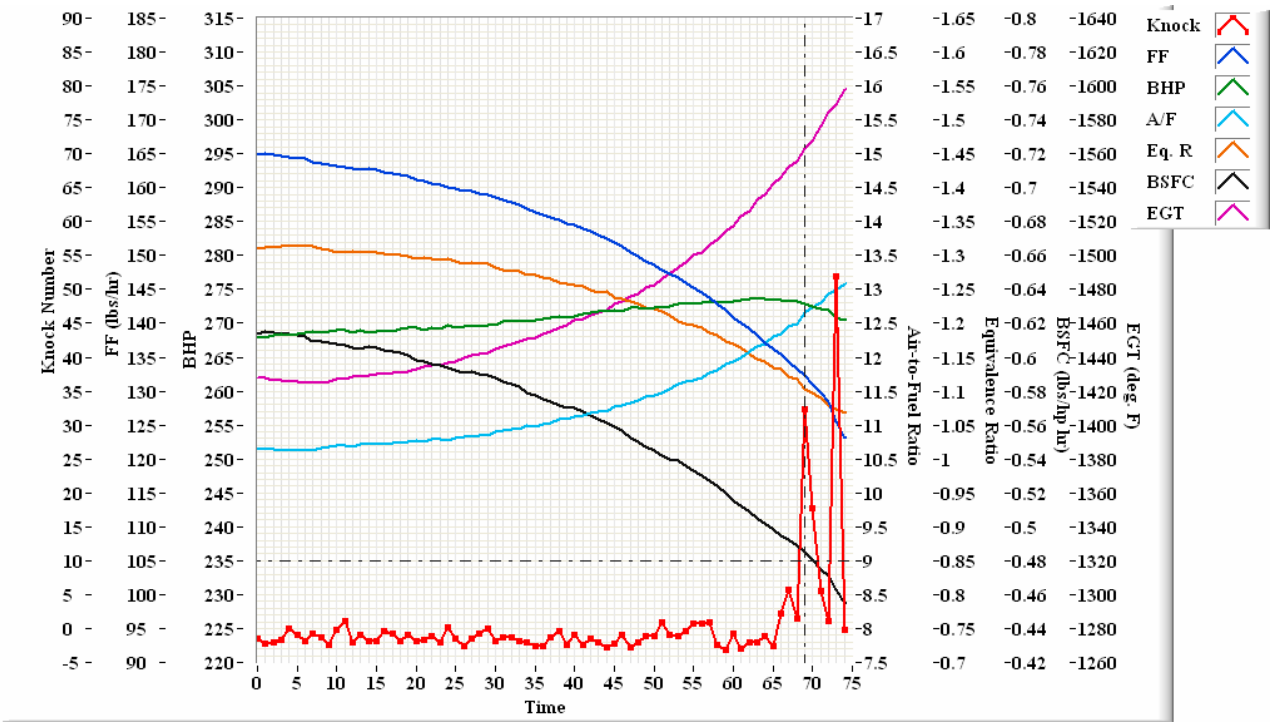


Figure B-97. Blend 26, 2700 rpm

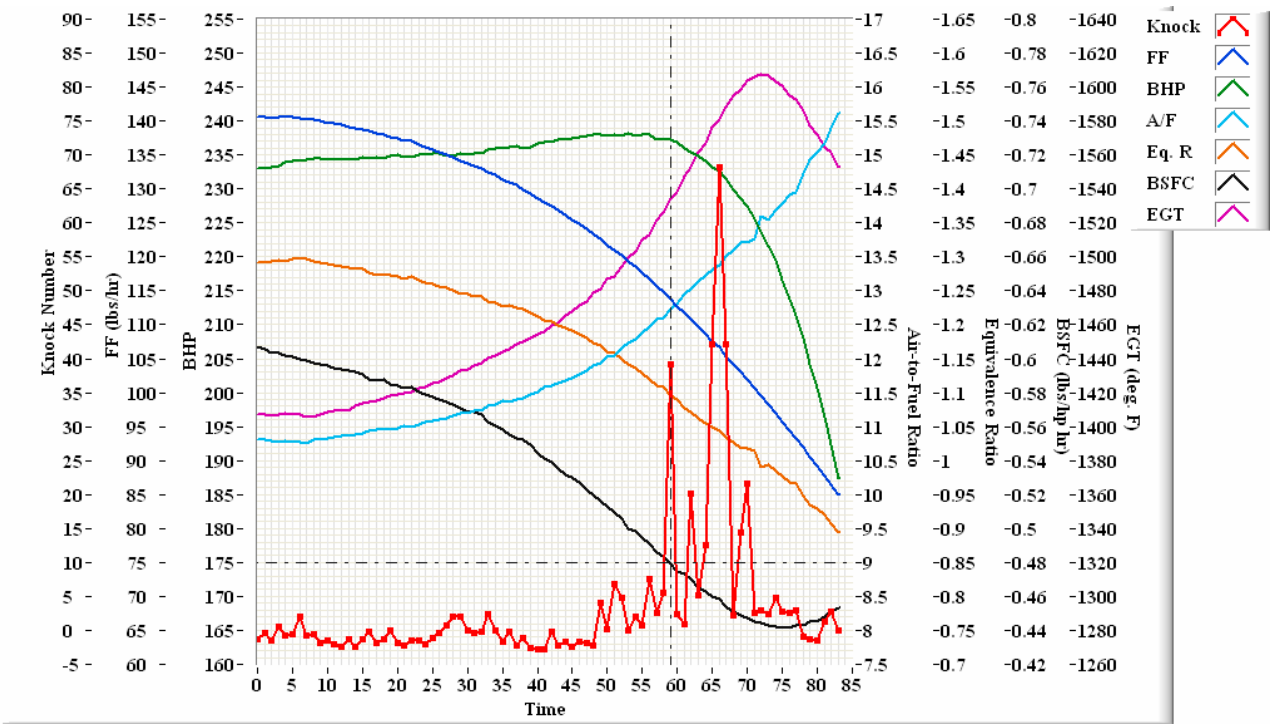


Figure B-98. Blend 26, 2600 rpm

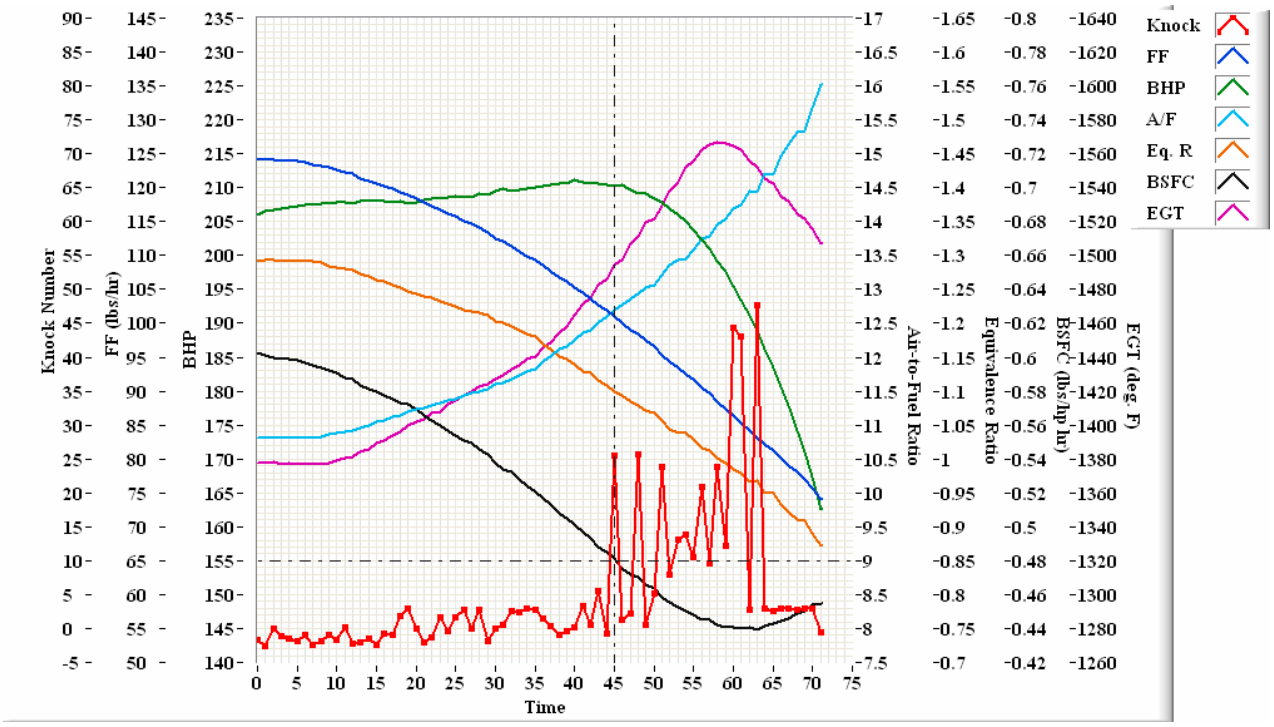


Figure B-99. Blend 26, 2450 rpm

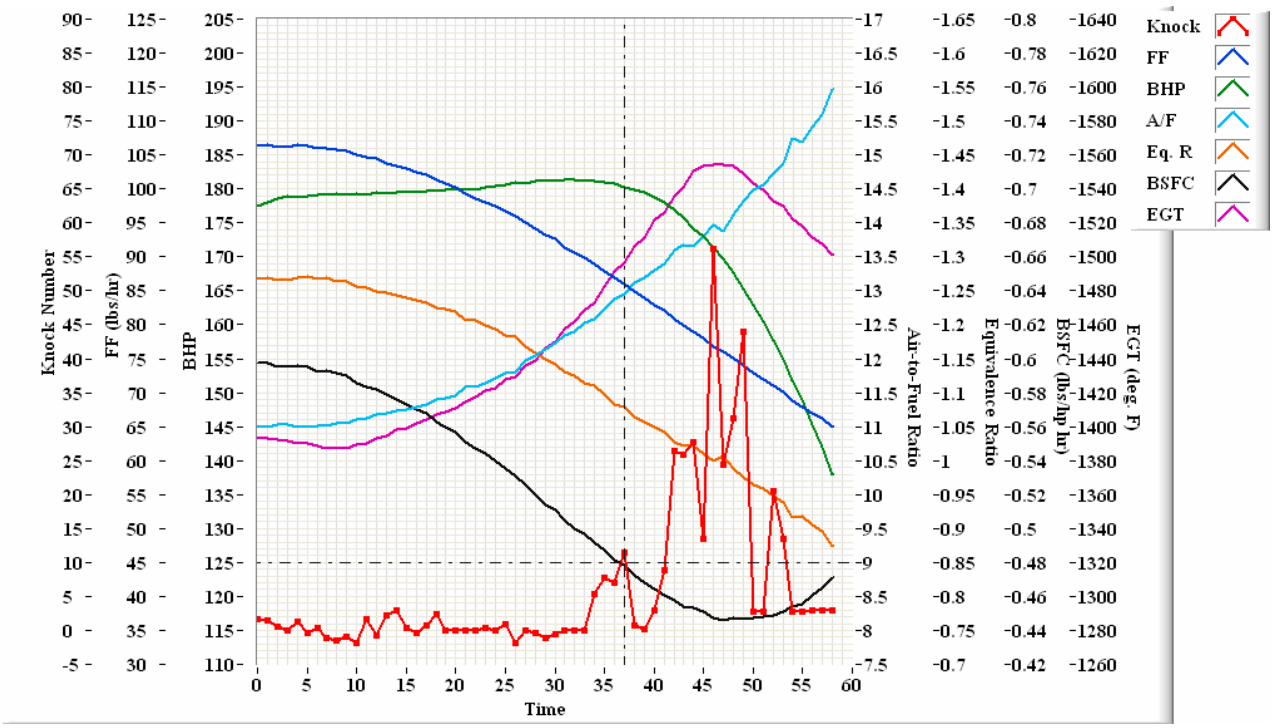


Figure B-100. Blend 26, 2350 rpm

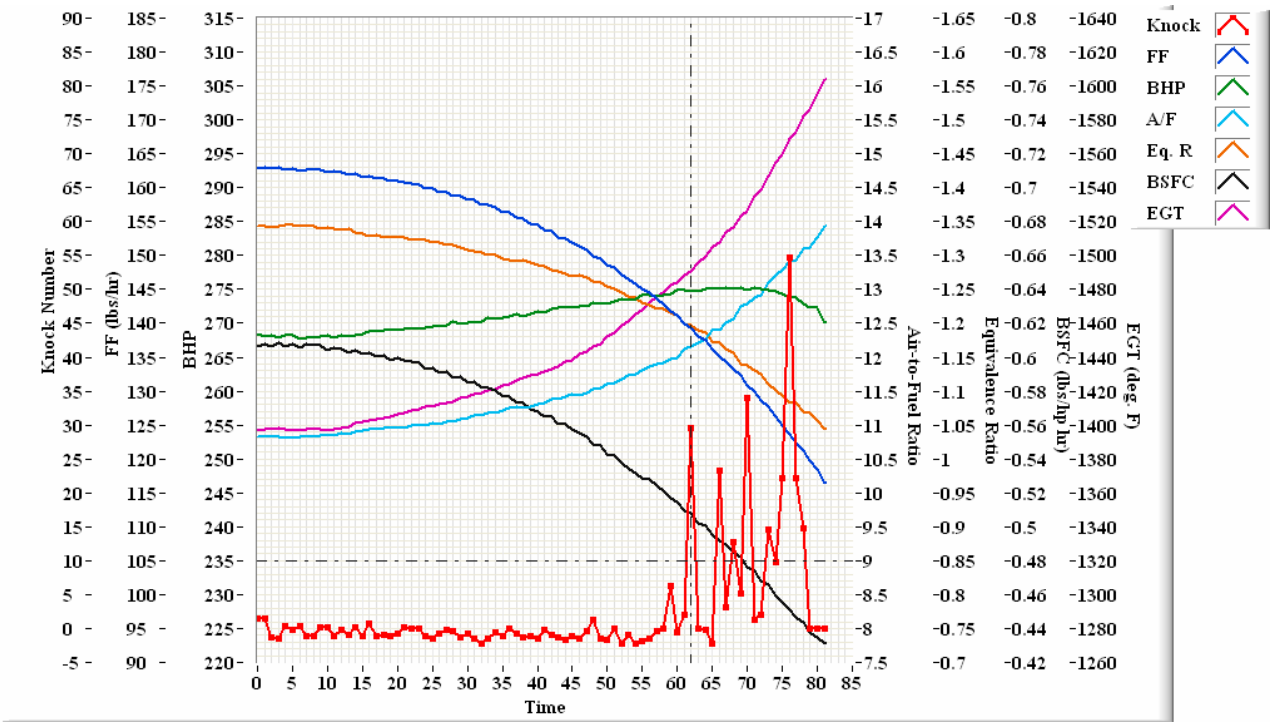


Figure B-101. Blend 27, 2700 rpm

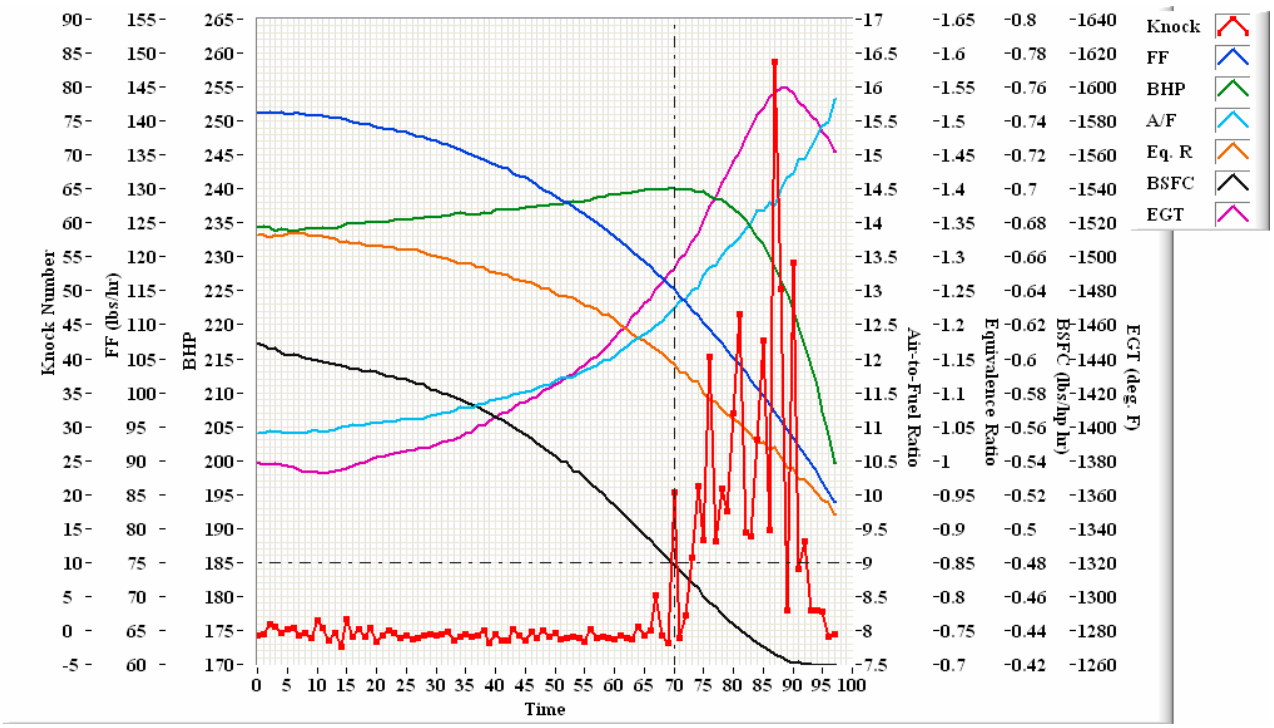


Figure B-102. Blend 27, 2600 rpm

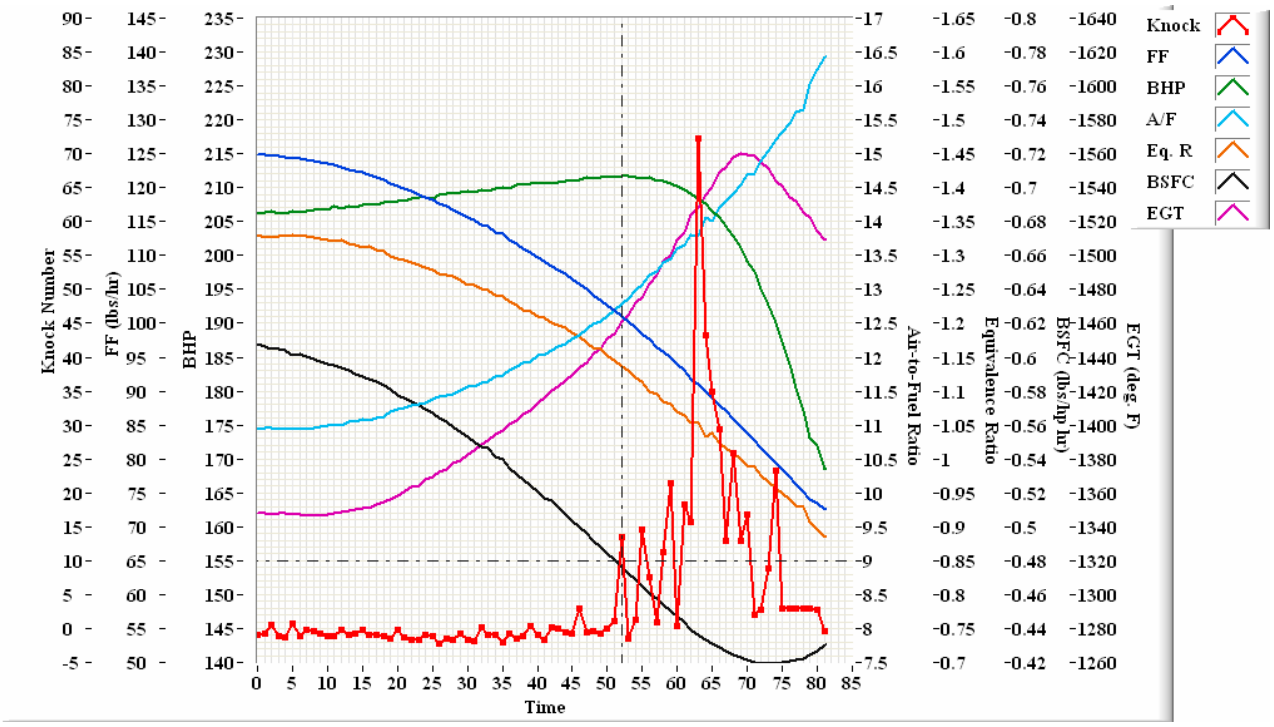


Figure B-103. Blend 27, 2450 rpm

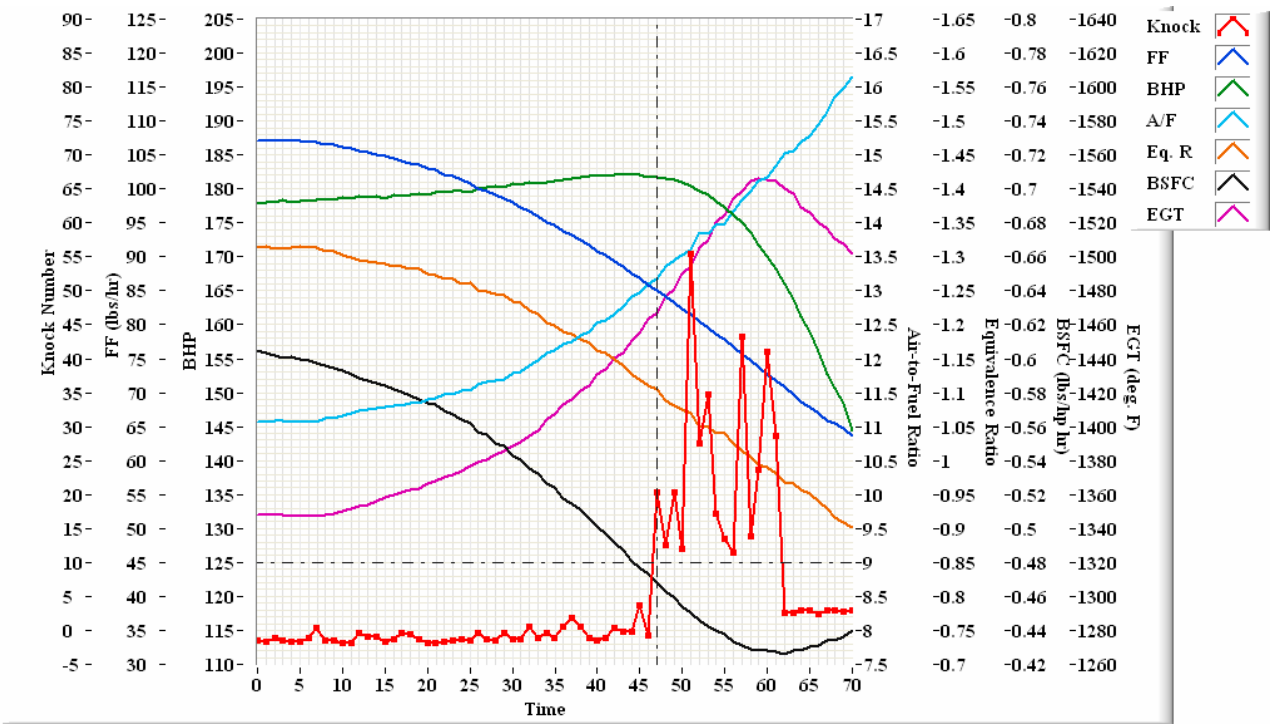


Figure B-104. Blend 27, 2350 rpm

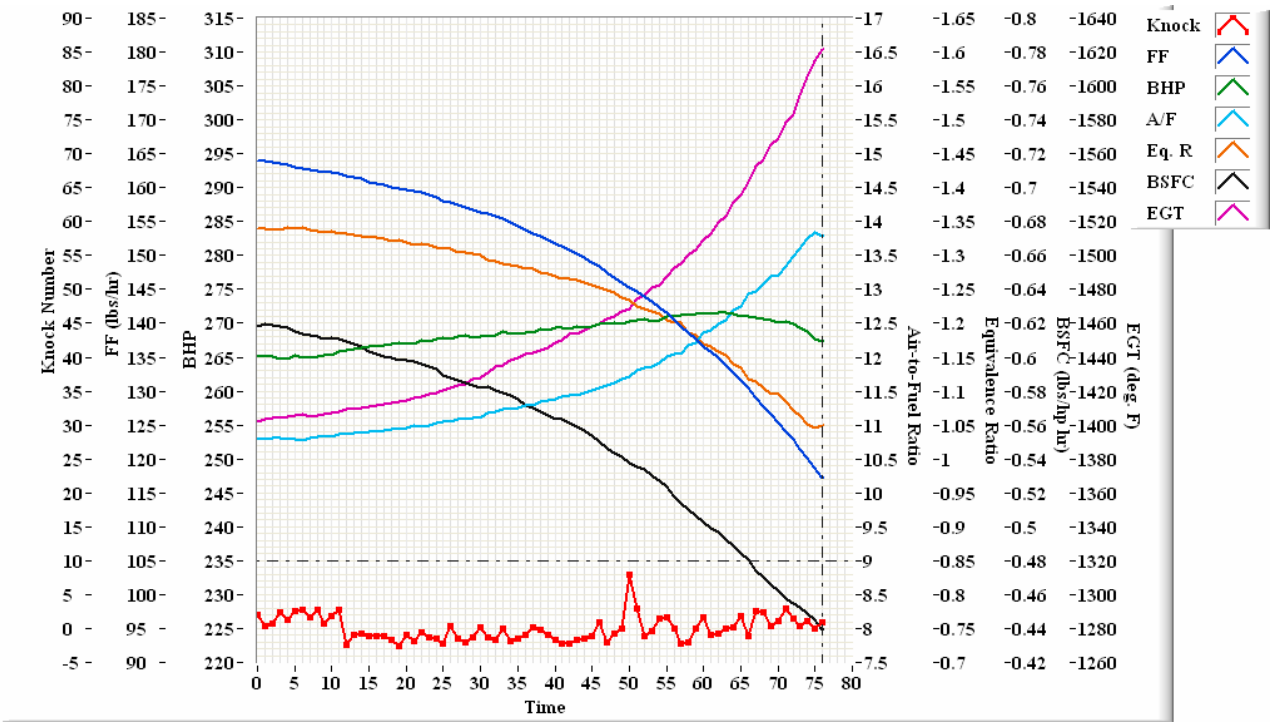


Figure B-105. Blend 28, 2700 rpm

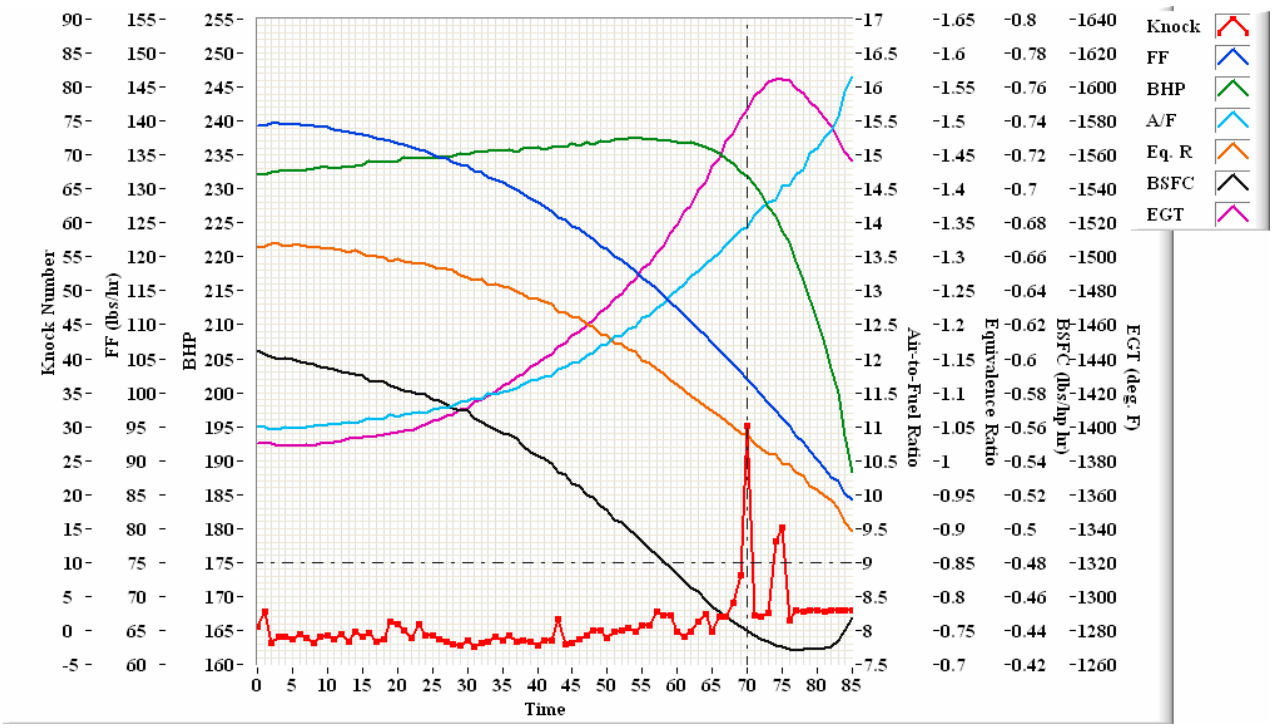


Figure B-106. Blend 28, 2600 rpm

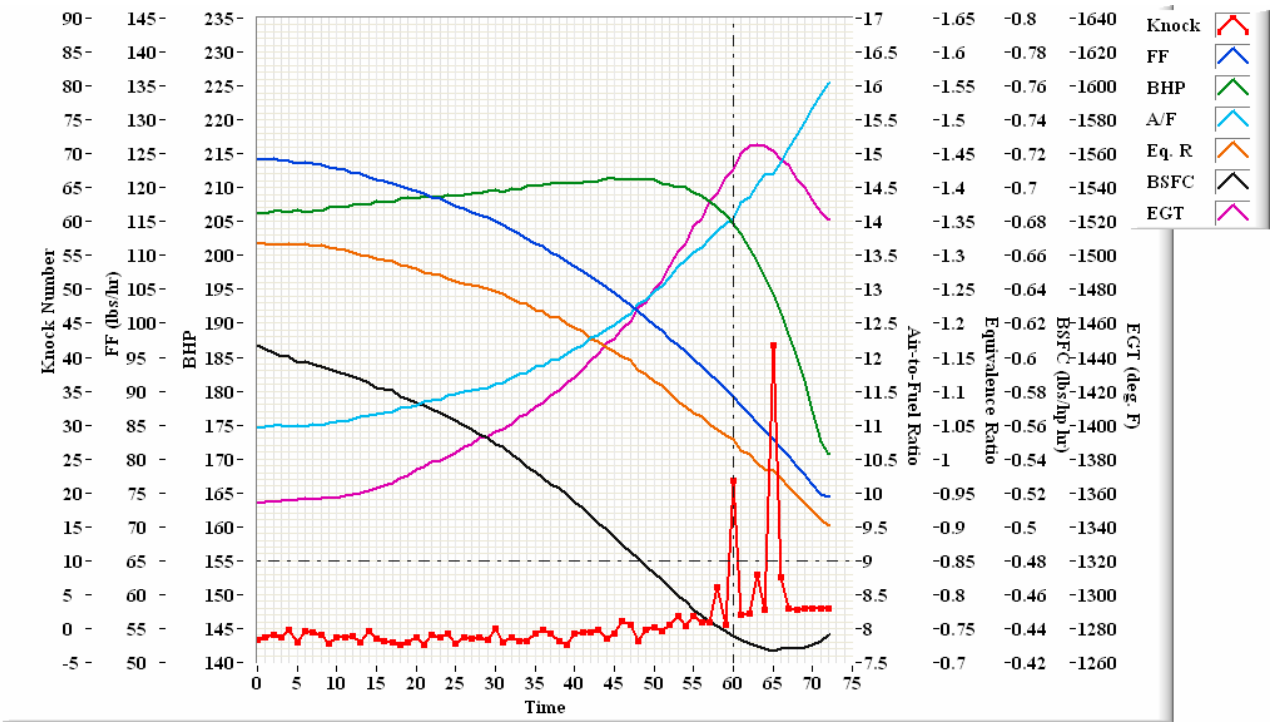


Figure B-107. Blend 28, 2450 rpm

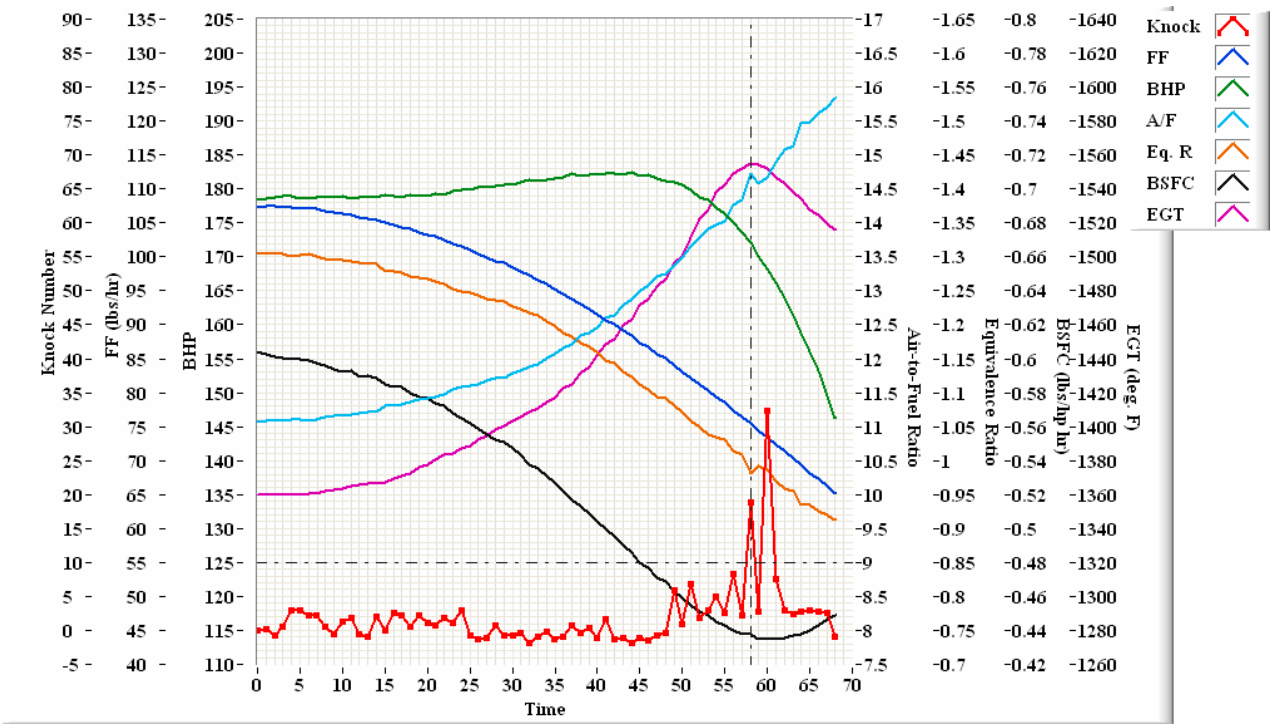


Figure B-108. Blend 28, 2350 rpm

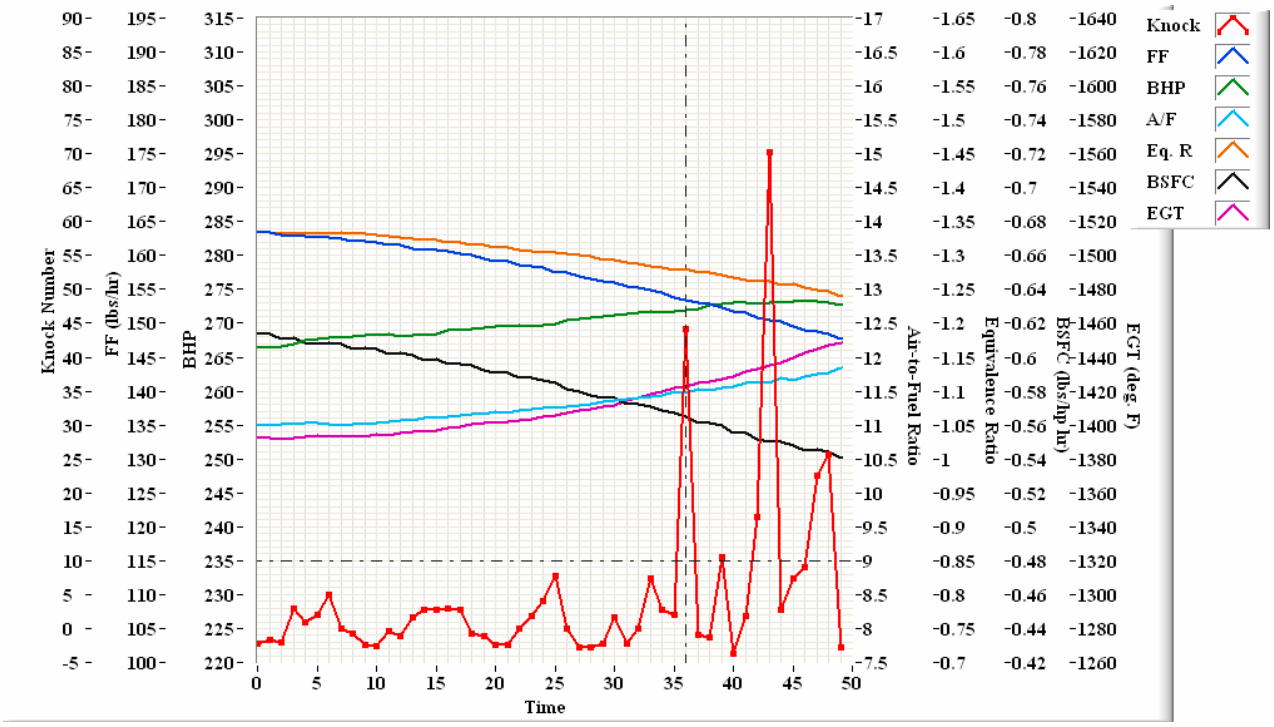


Figure B-109. Blend 29, 2700 rpm

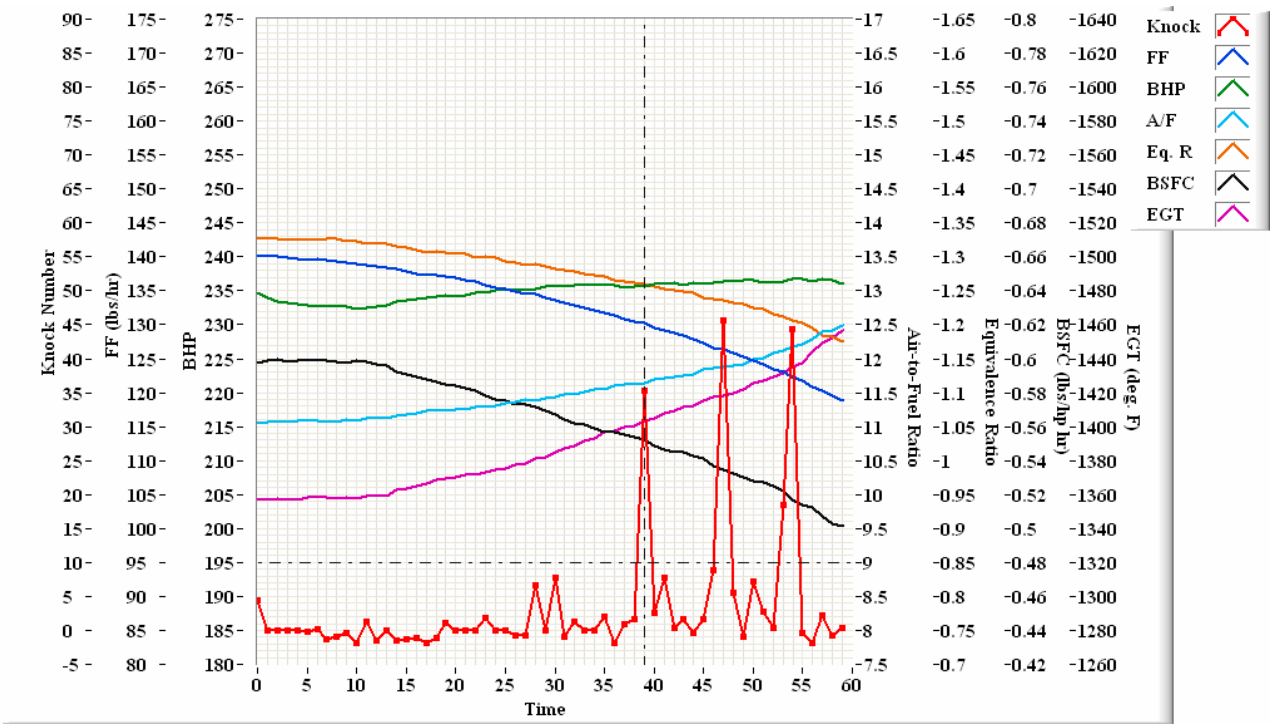


Figure B-110. Blend 29, 2600 rpm

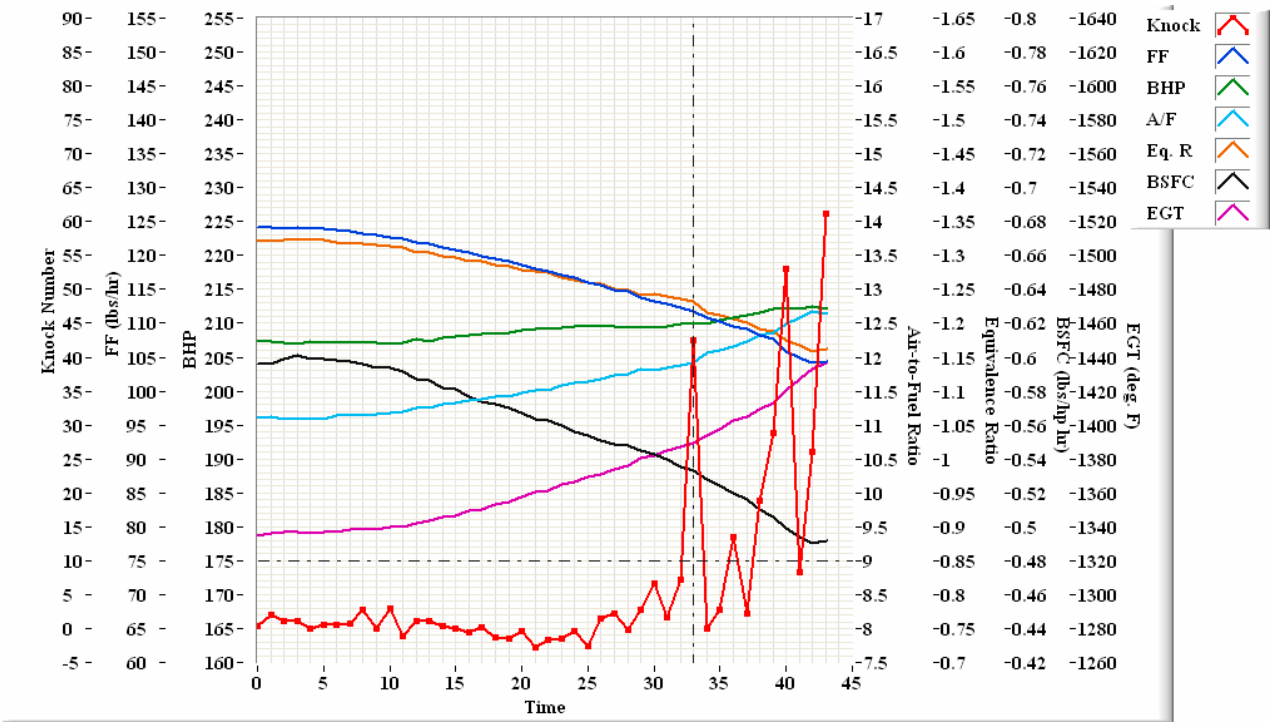


Figure B-111. Blend 29, 2450 rpm

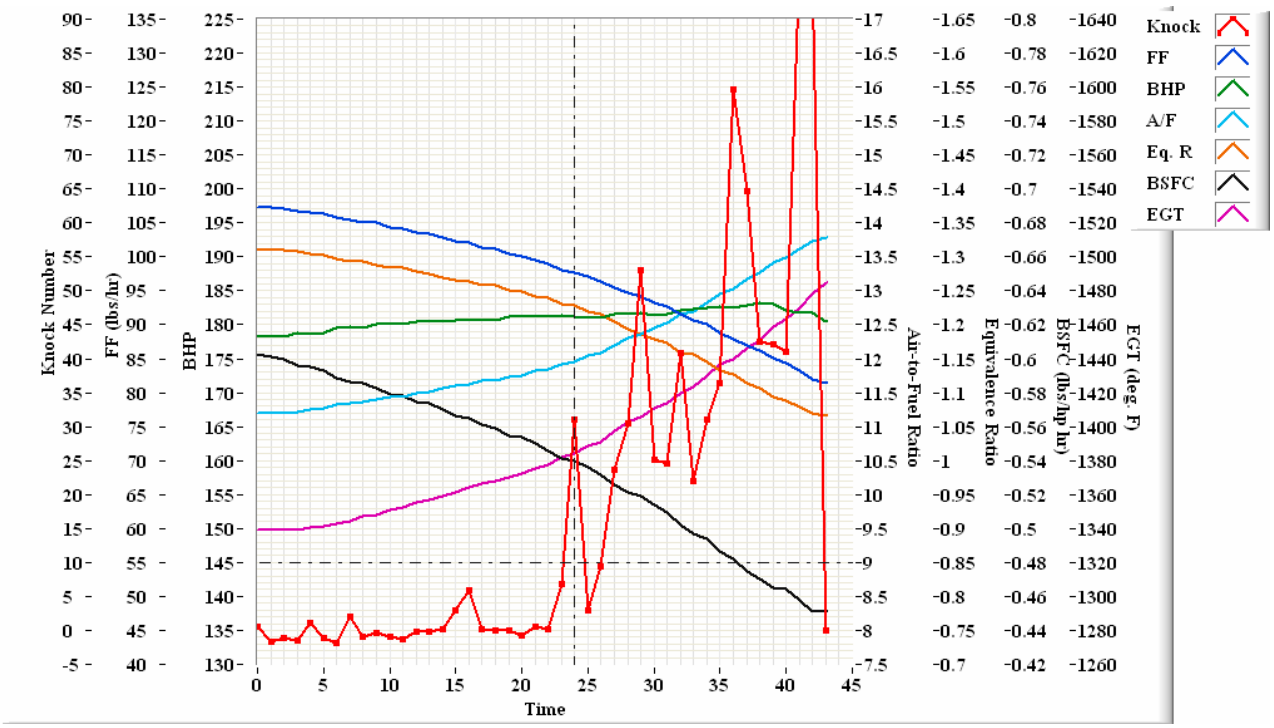


Figure B-112. Blend 29, 2350 rpm

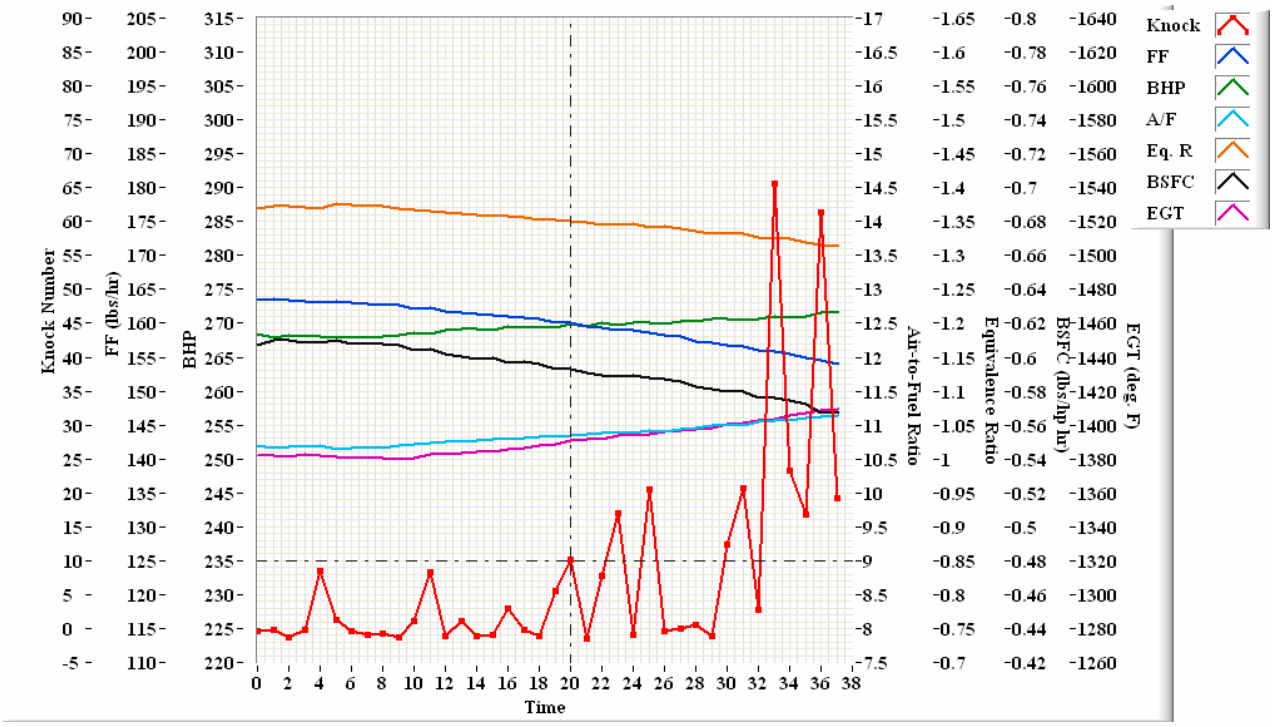


Figure B-113. Blend 30, 2700 rpm

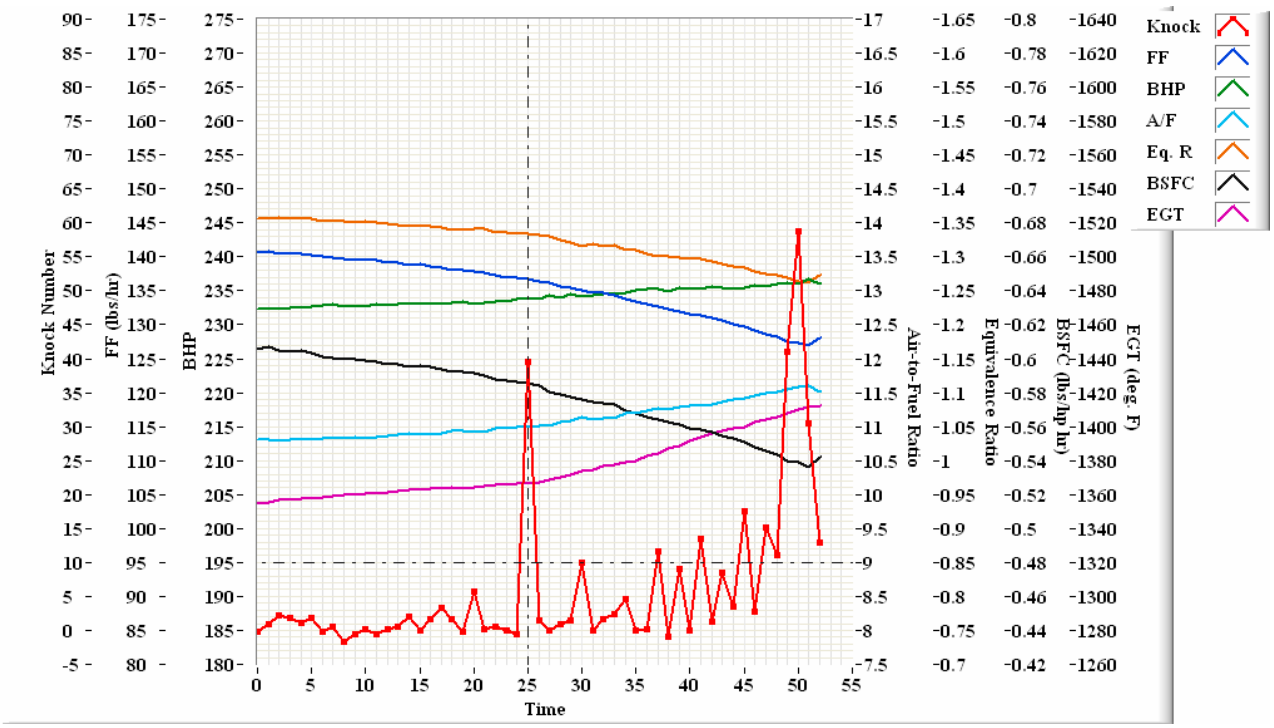


Figure B-114. Blend 30, 2600 rpm

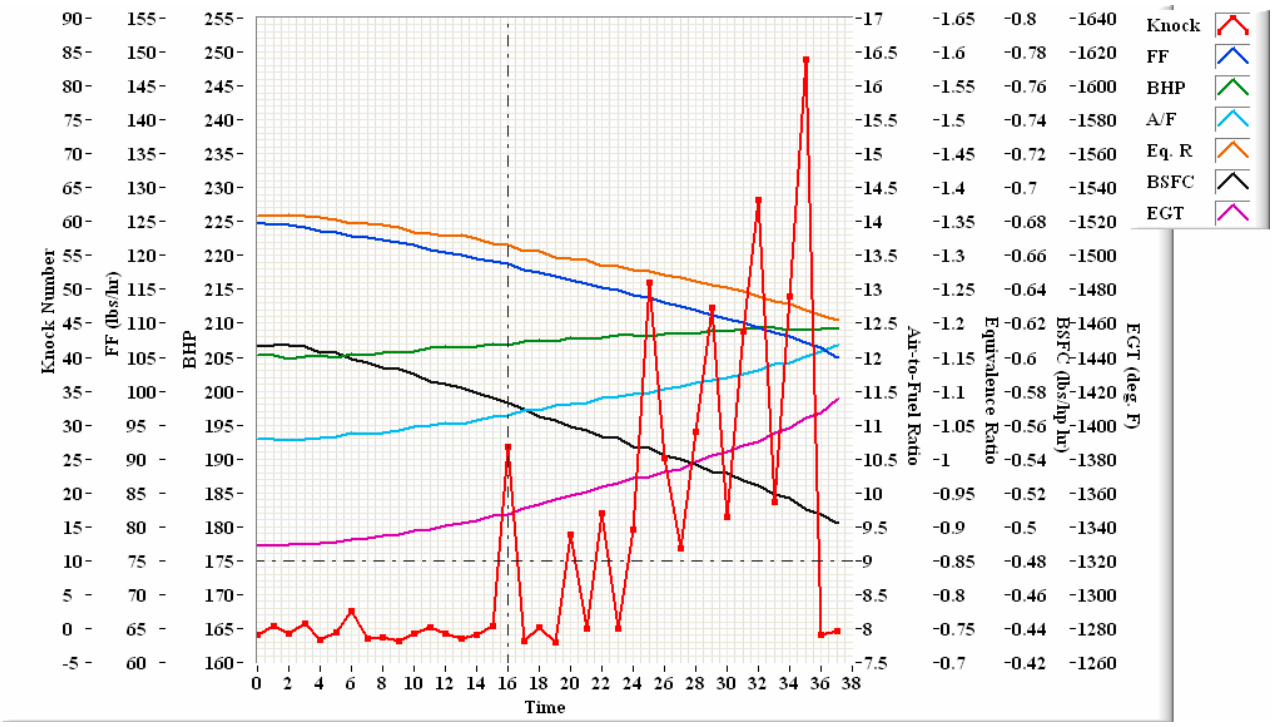


Figure B-115. Blend 30, 2450 rpm

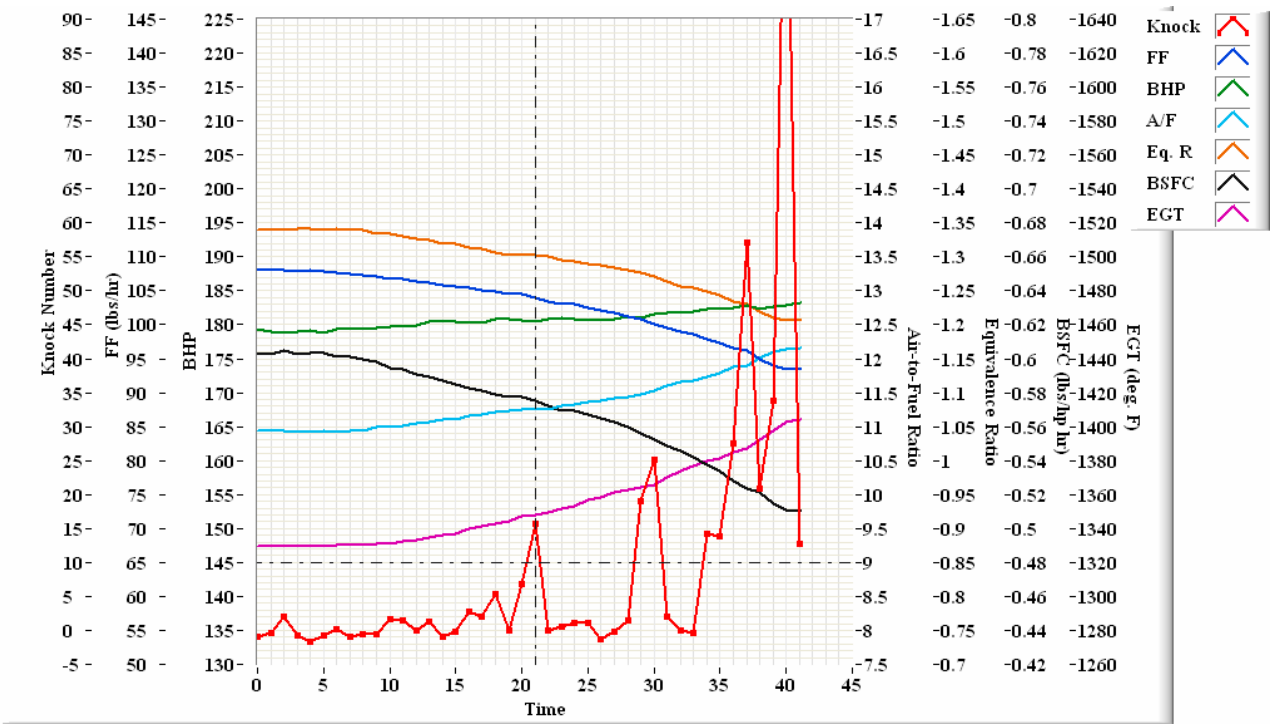


Figure B-116. Blend 30, 2350 rpm

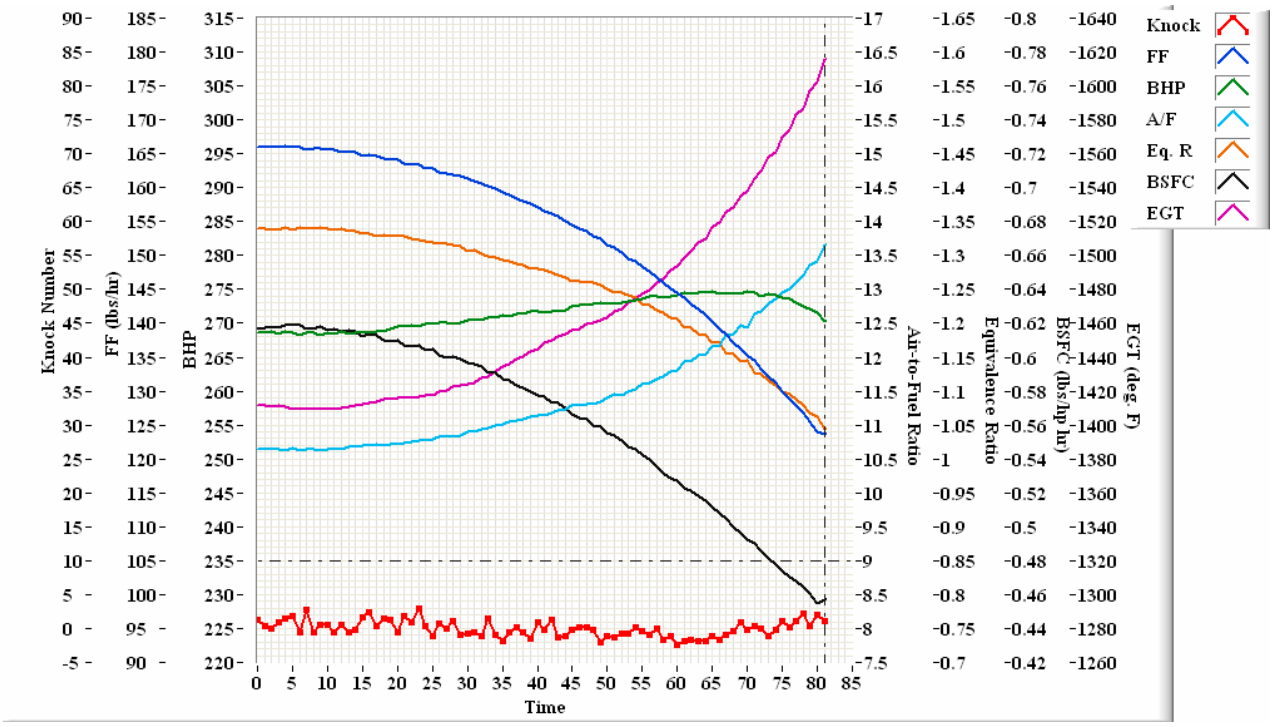


Figure B-117. Blend 31, 2700 rpm

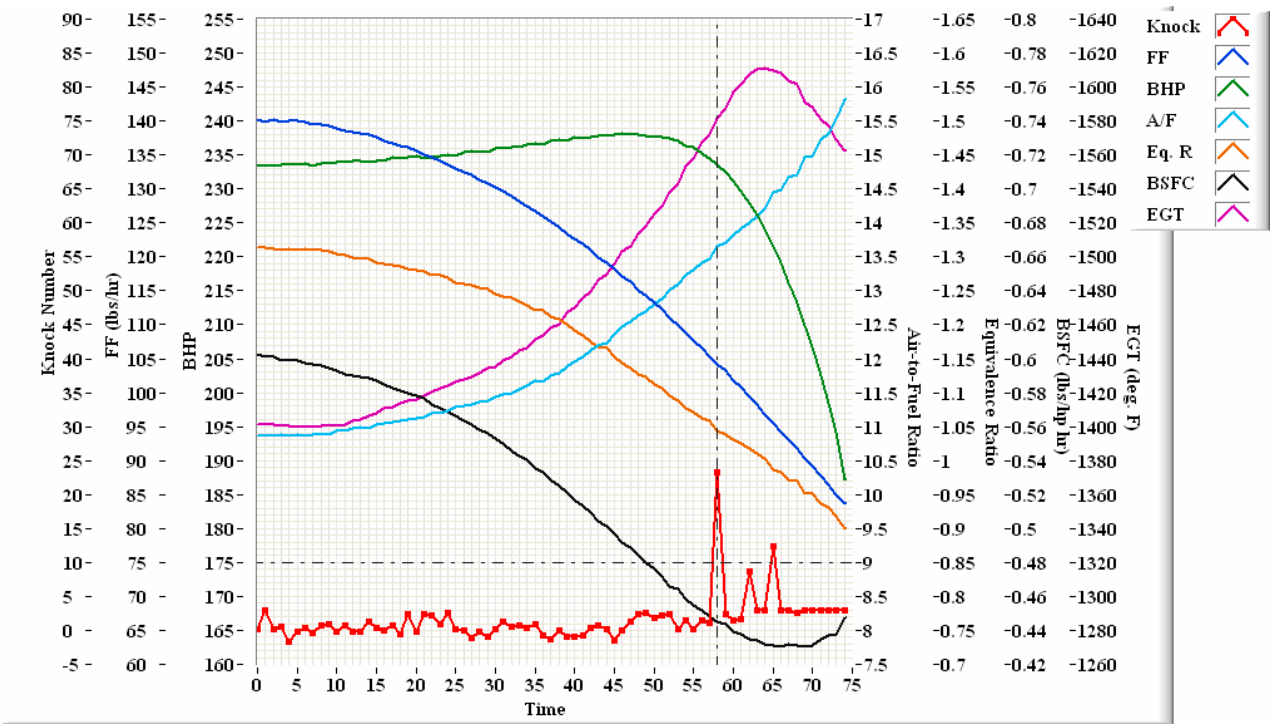


Figure B-118. Blend 31, 2600 rpm

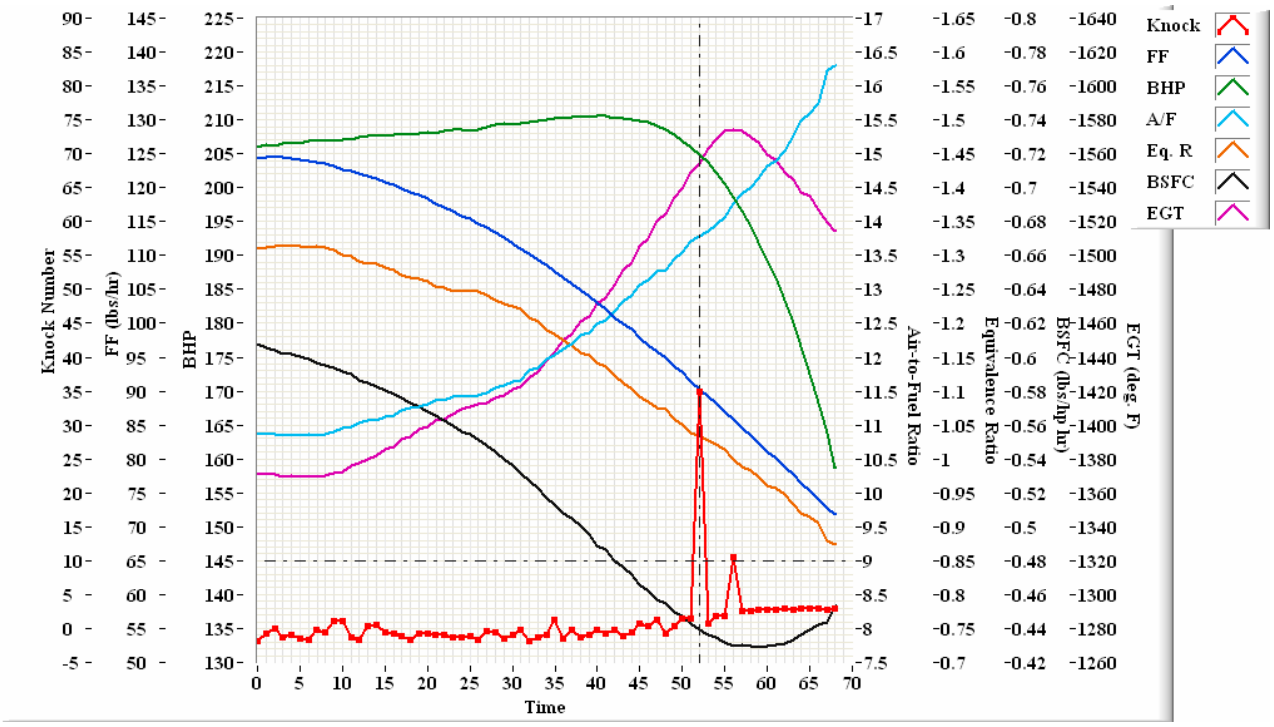


Figure B-119. Blend 31, 2450 rpm

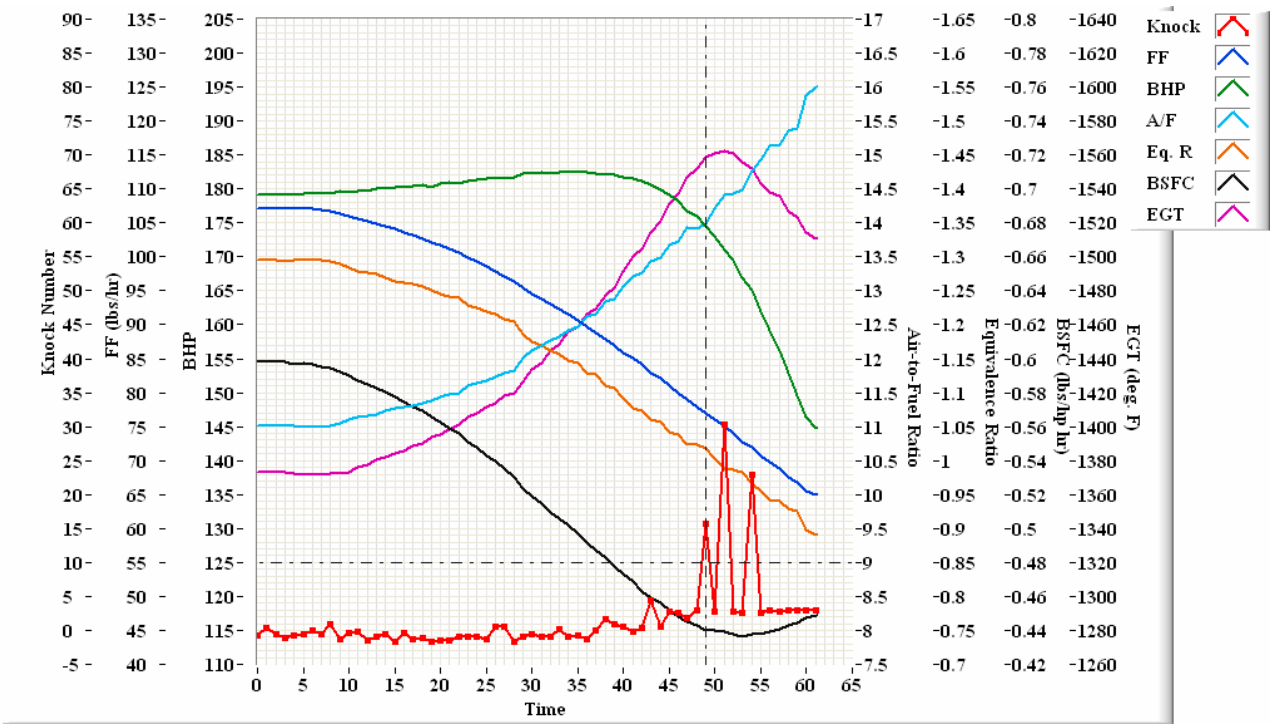


Figure B-120. Blend 31, 2350 rpm

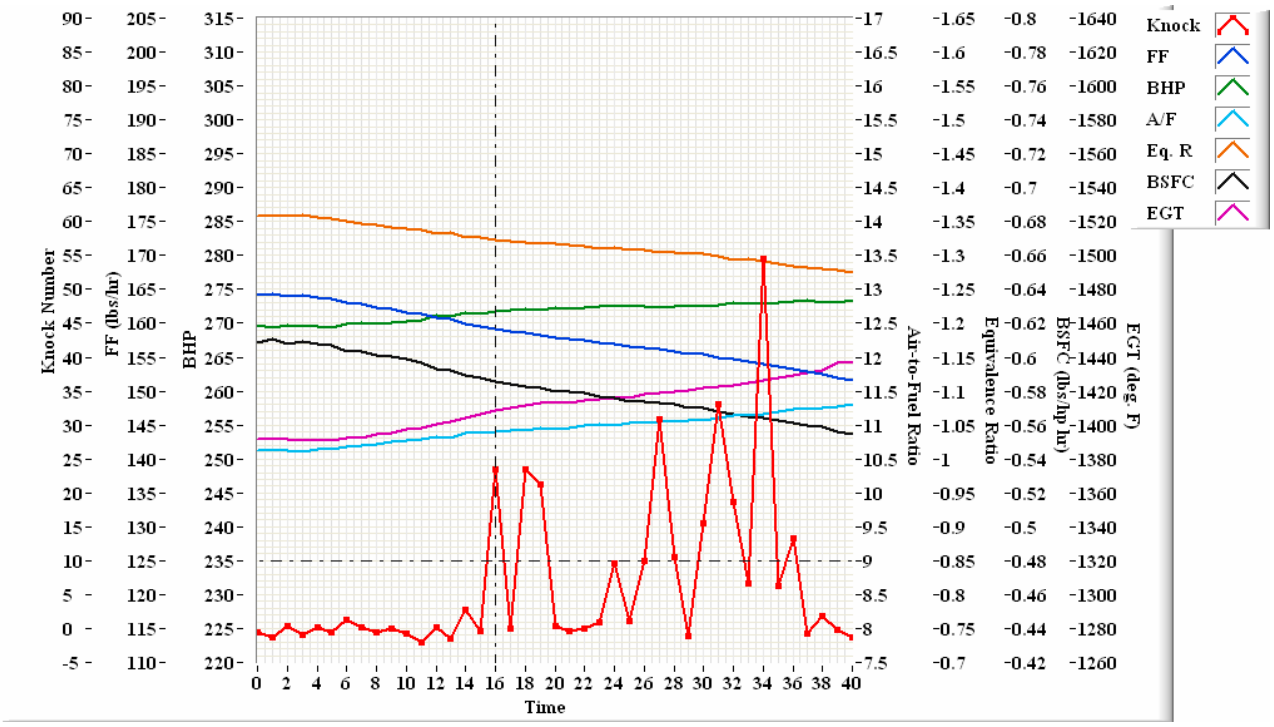


Figure B-121. Blend 32, 2700 rpm

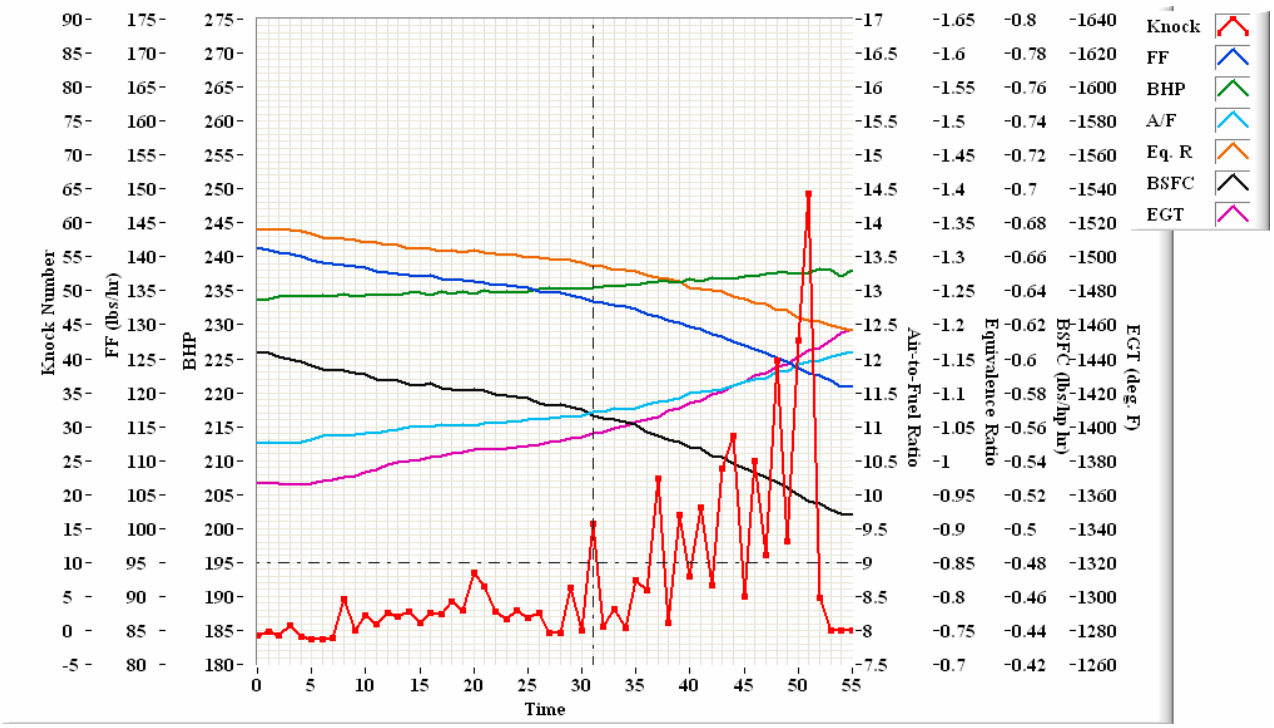


Figure B-122. Blend 32, 2600 rpm

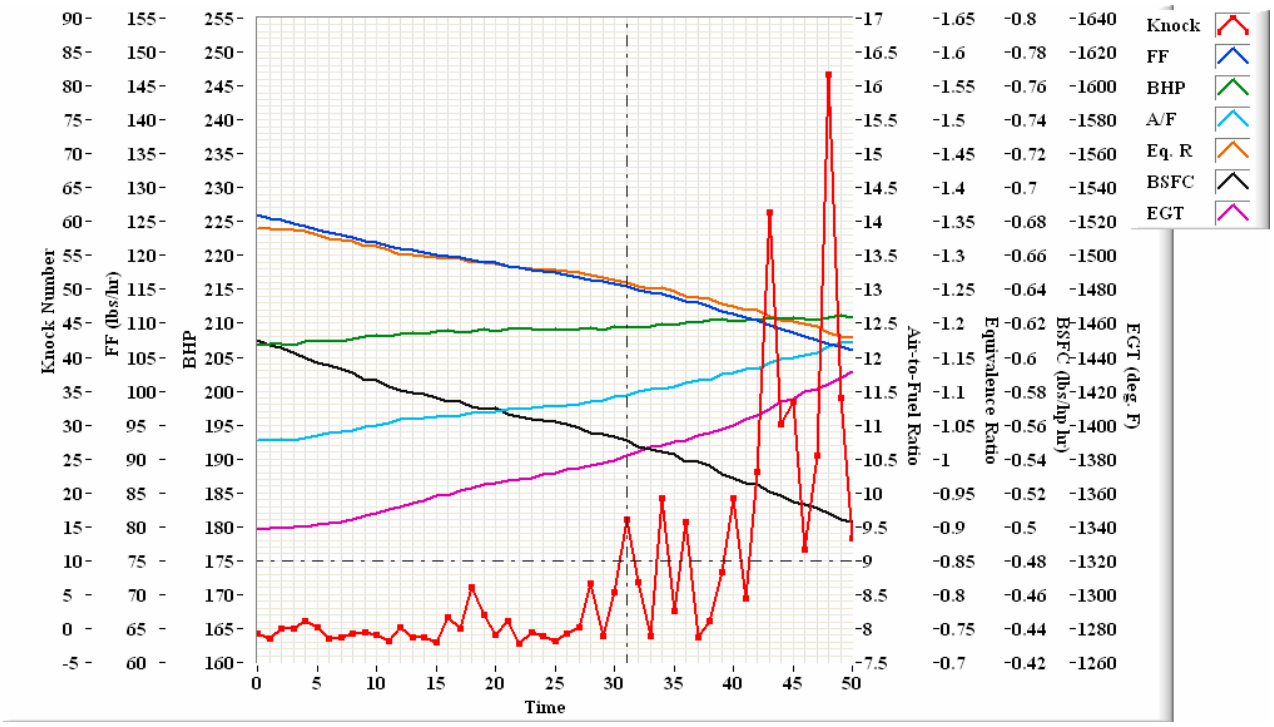


Figure B-123. Blend 32, 2450 rpm

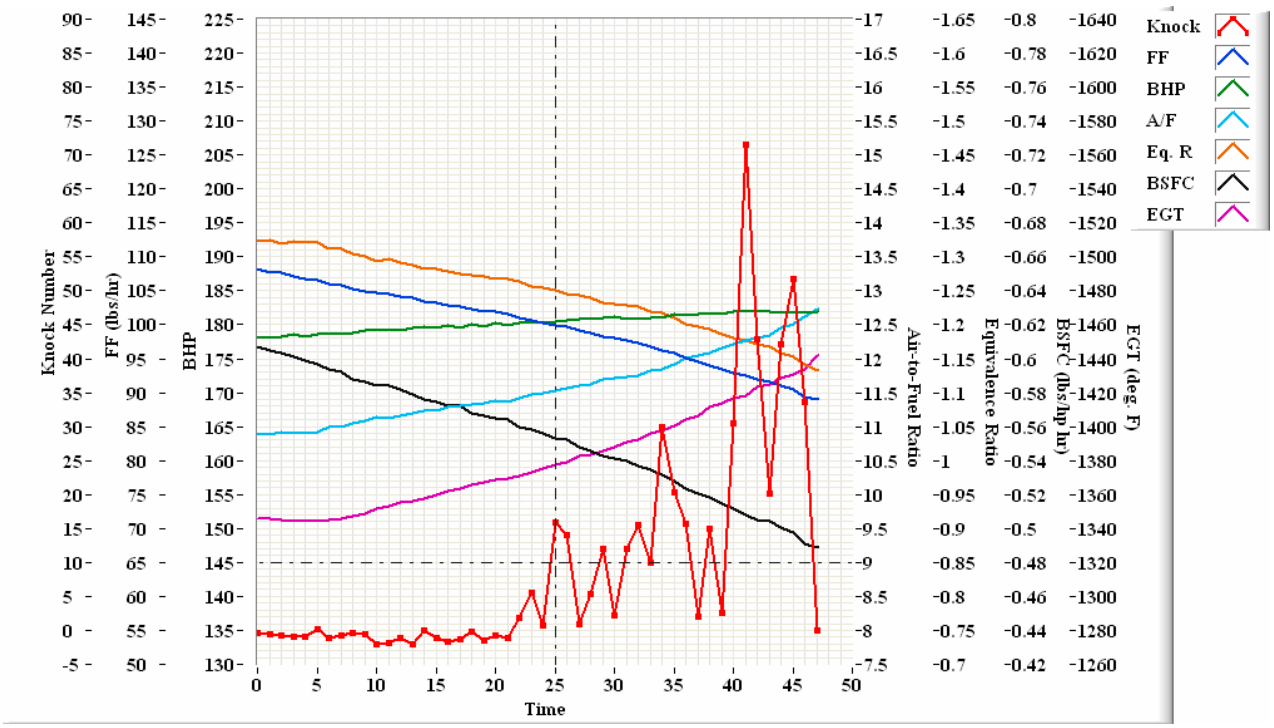


Figure B-124. Blend 32, 2350 rpm

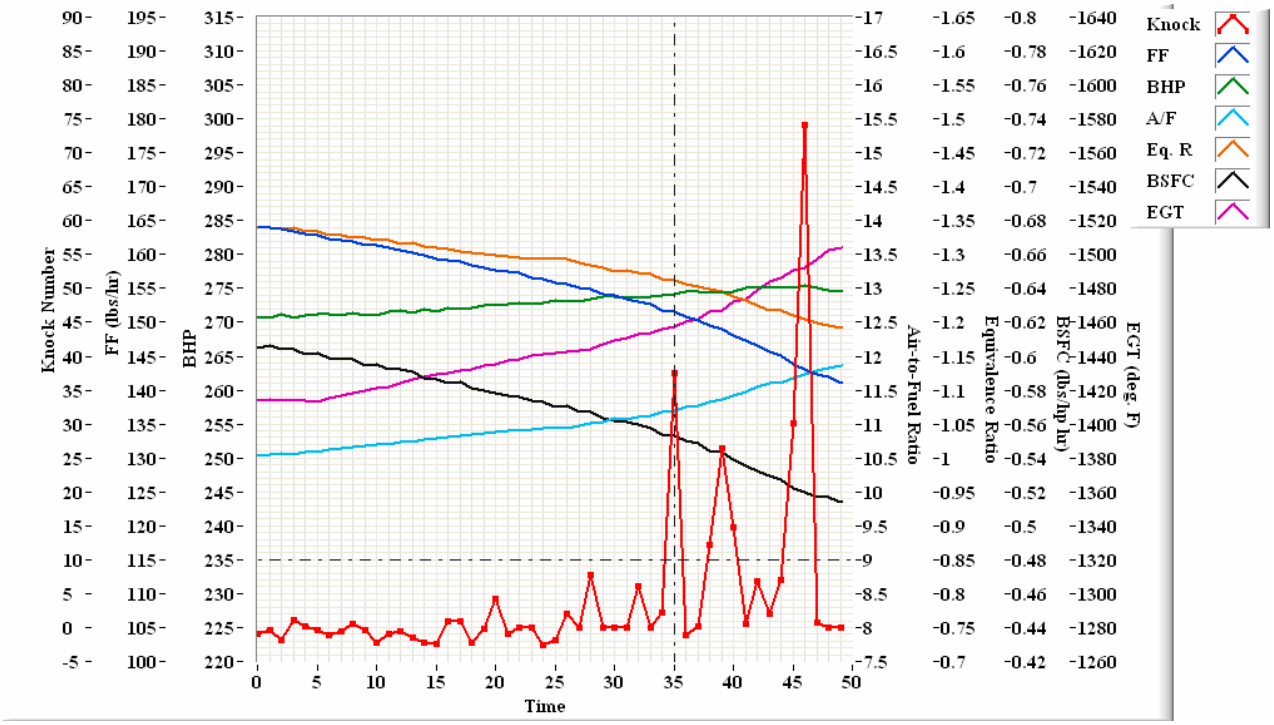


Figure B-125. Blend 33, 2700 rpm

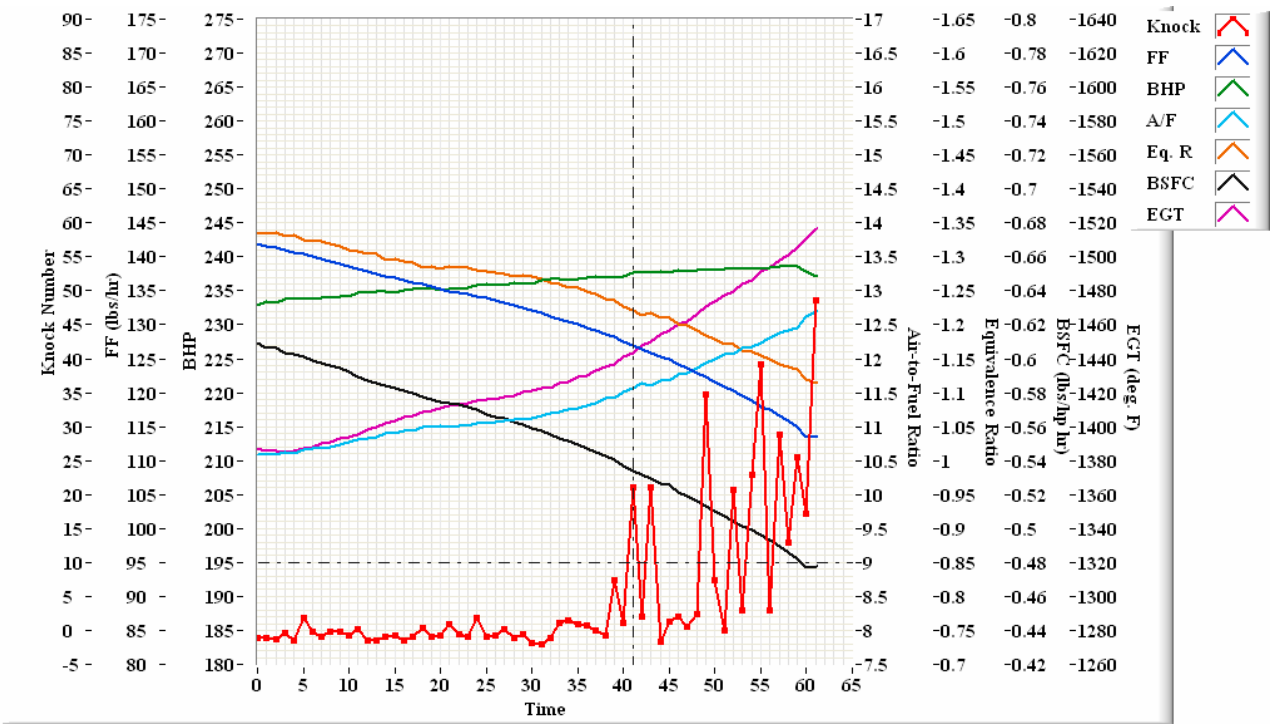


Figure B-126. Blend 33, 2600 rpm

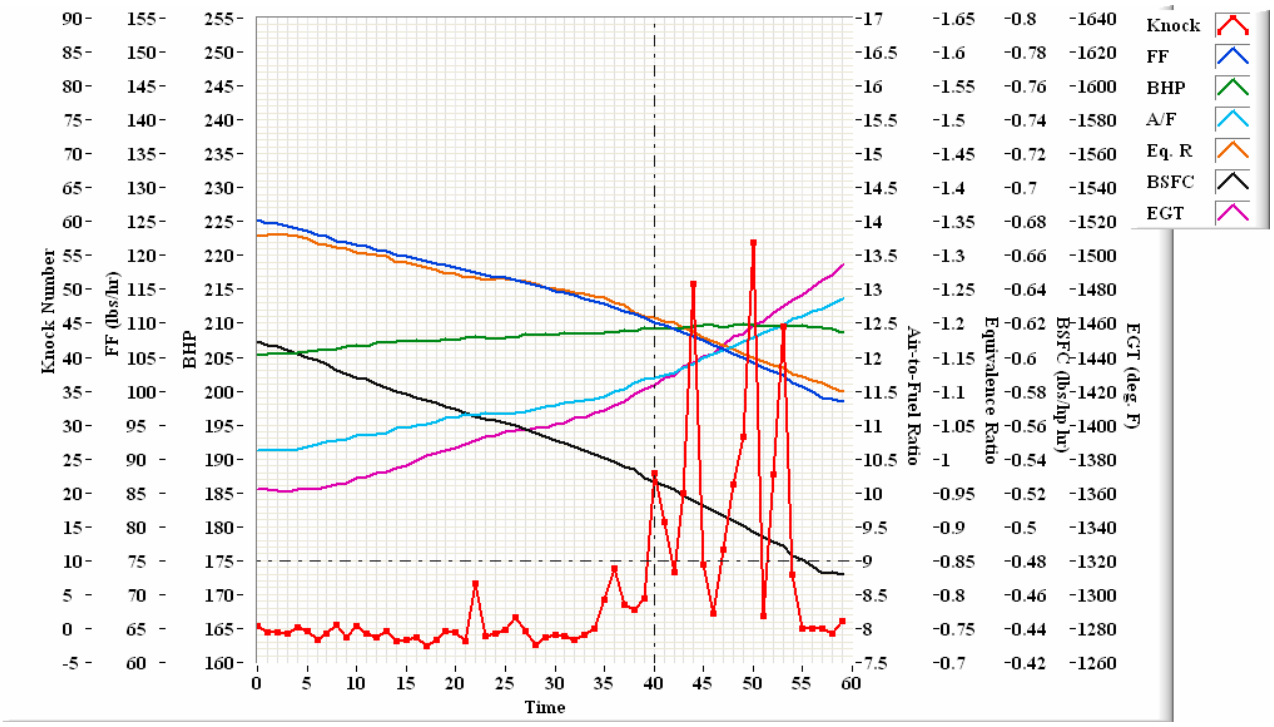


Figure B-127. Blend 33, 2450 rpm

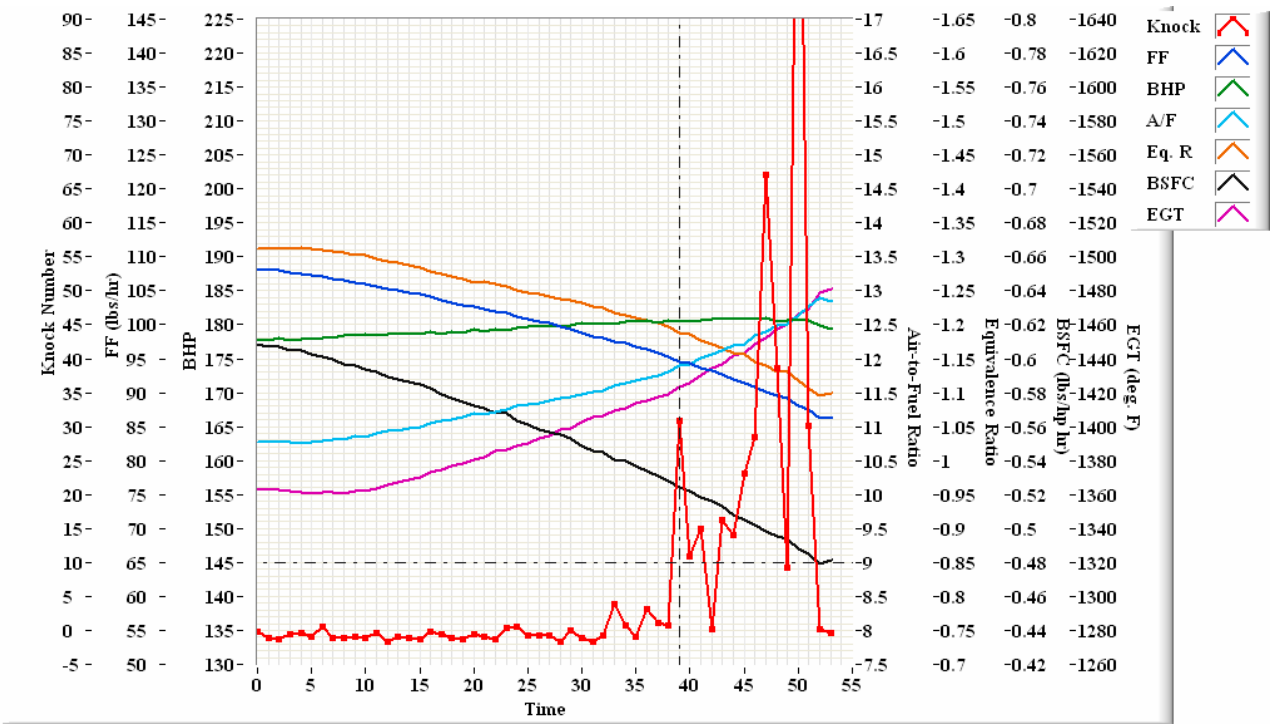


Figure B-128. Blend 33, 2350 rpm

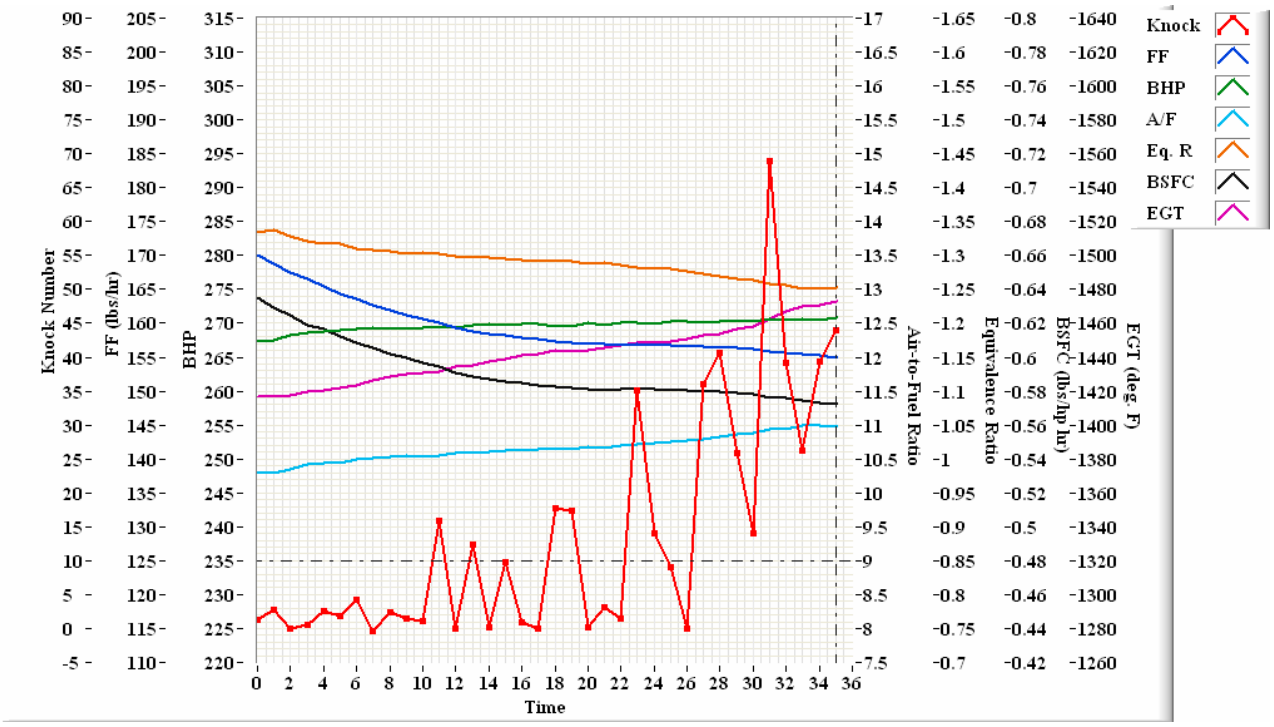


Figure B-129. Blend 34, 2700 rpm

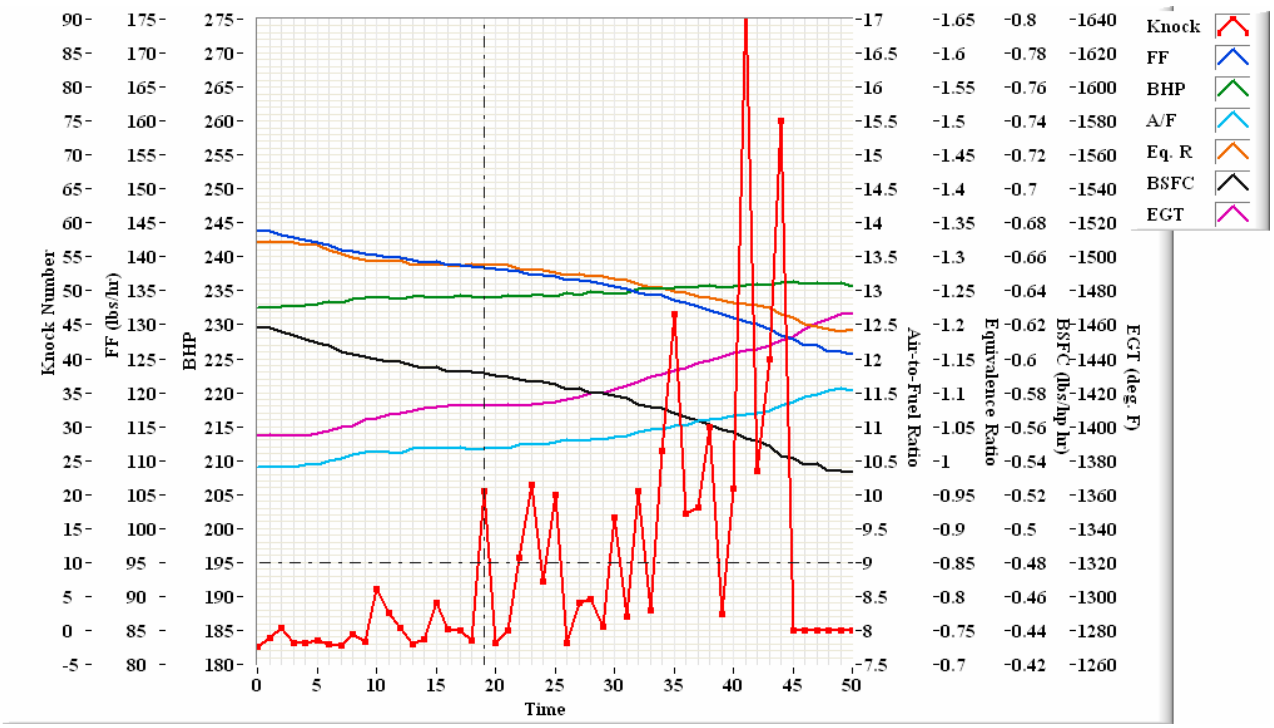


Figure B-130. Blend 34, 2600 rpm

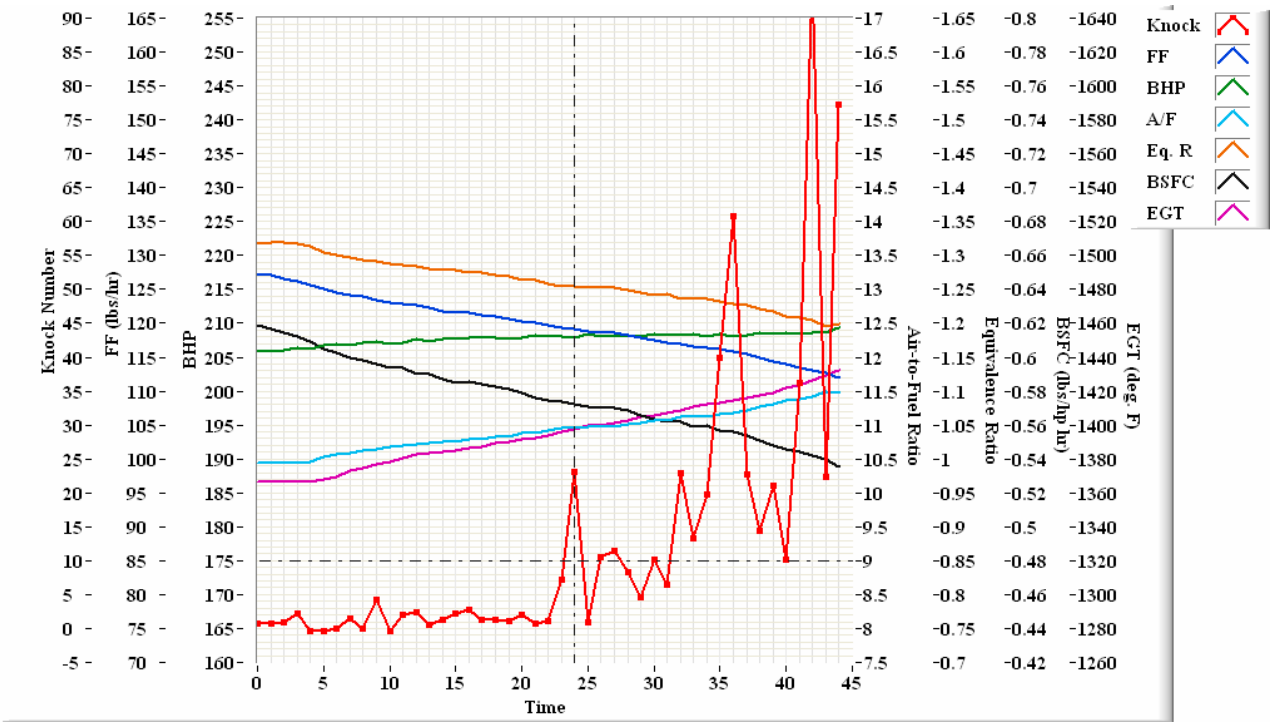


Figure B-131. Blend 34, 2450 rpm

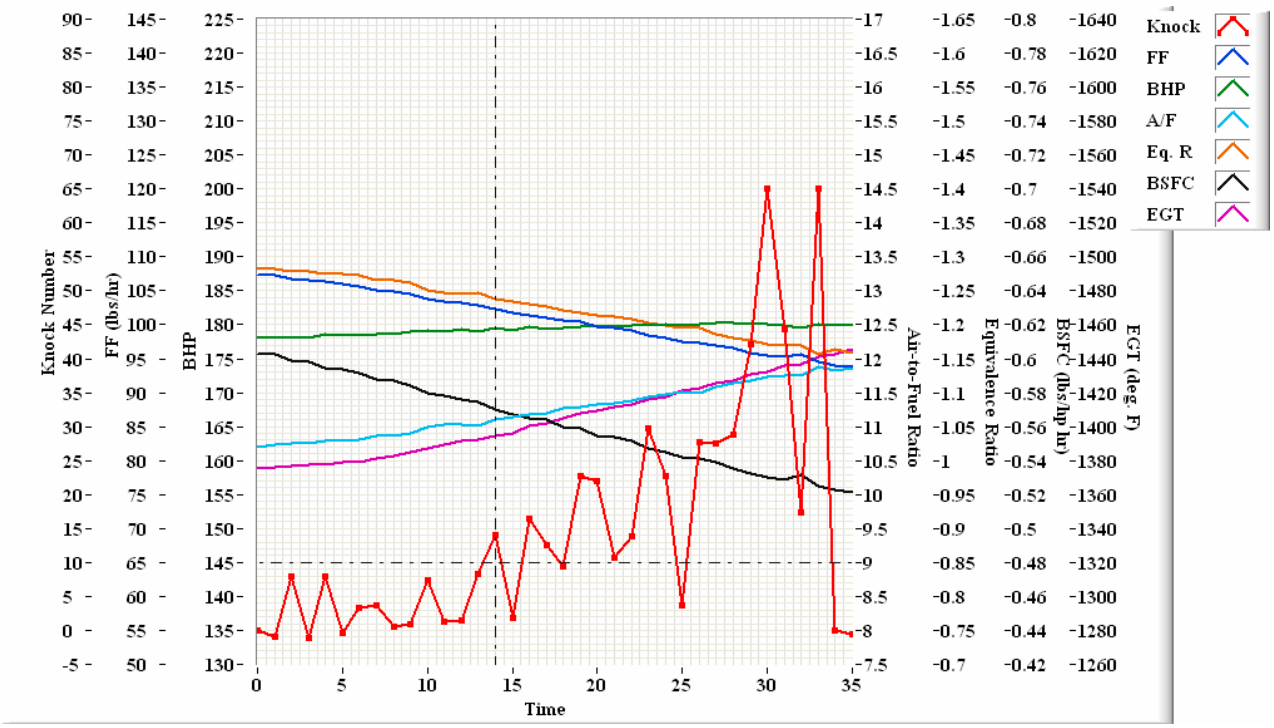


Figure B-132. Blend 34, 2350 rpm

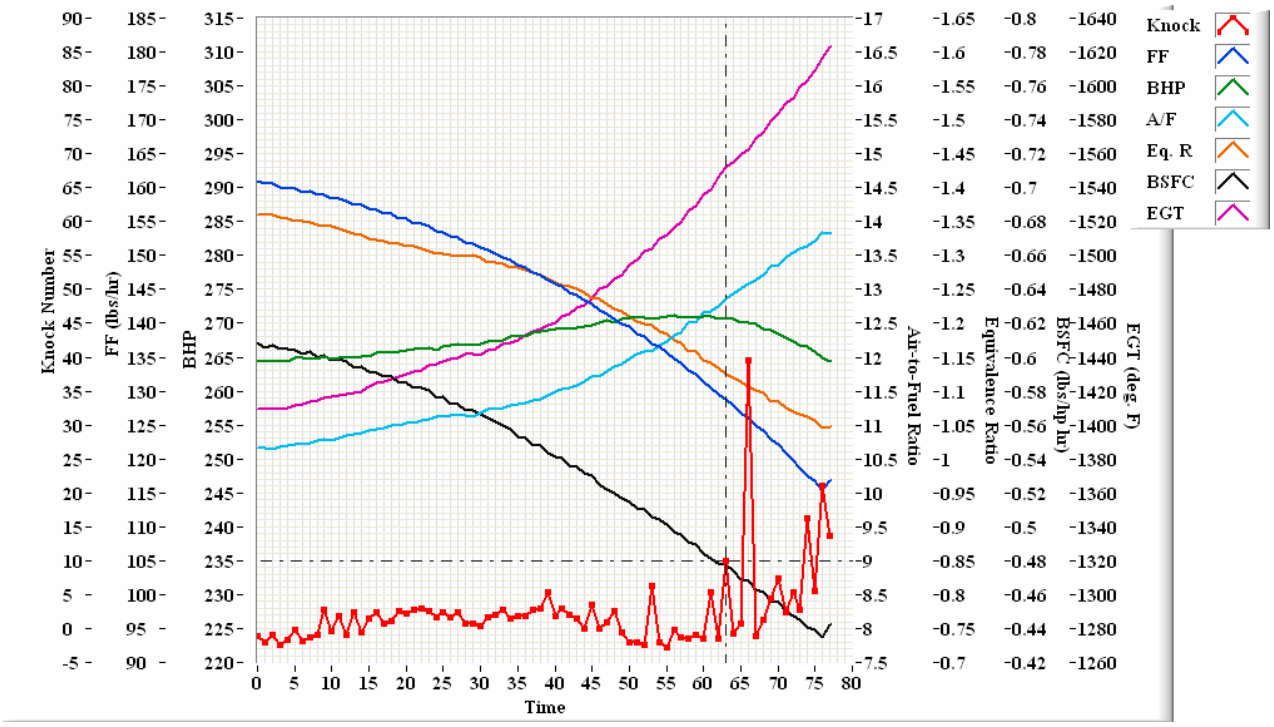


Figure B-133. Blend 35, 2700 rpm

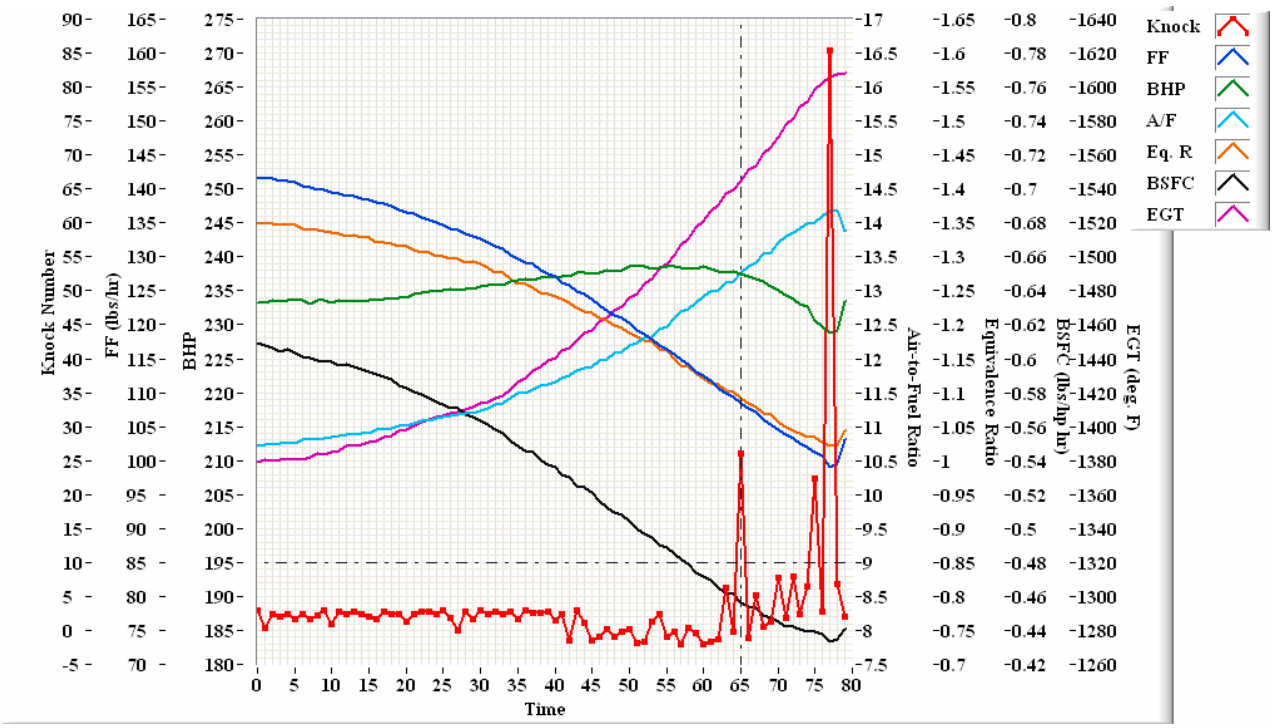


Figure B-134. Blend 35, 2600 rpm

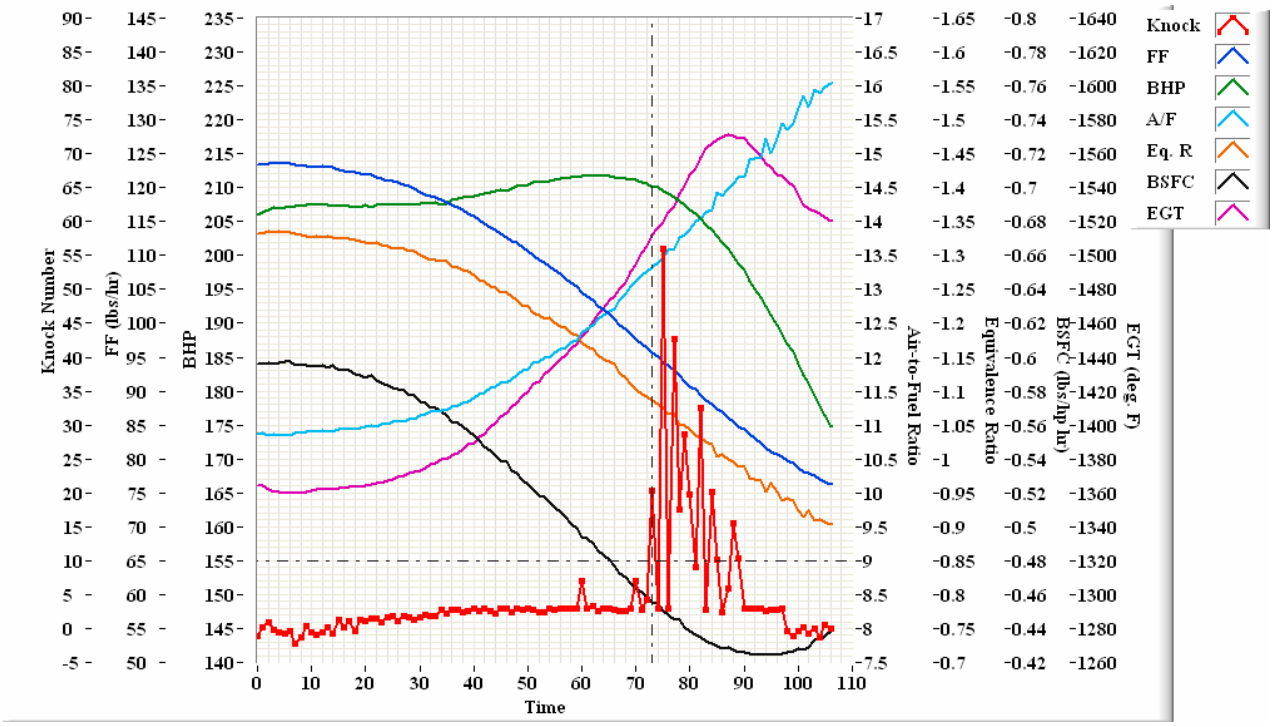


Figure B-135. Blend 35, 2450 rpm

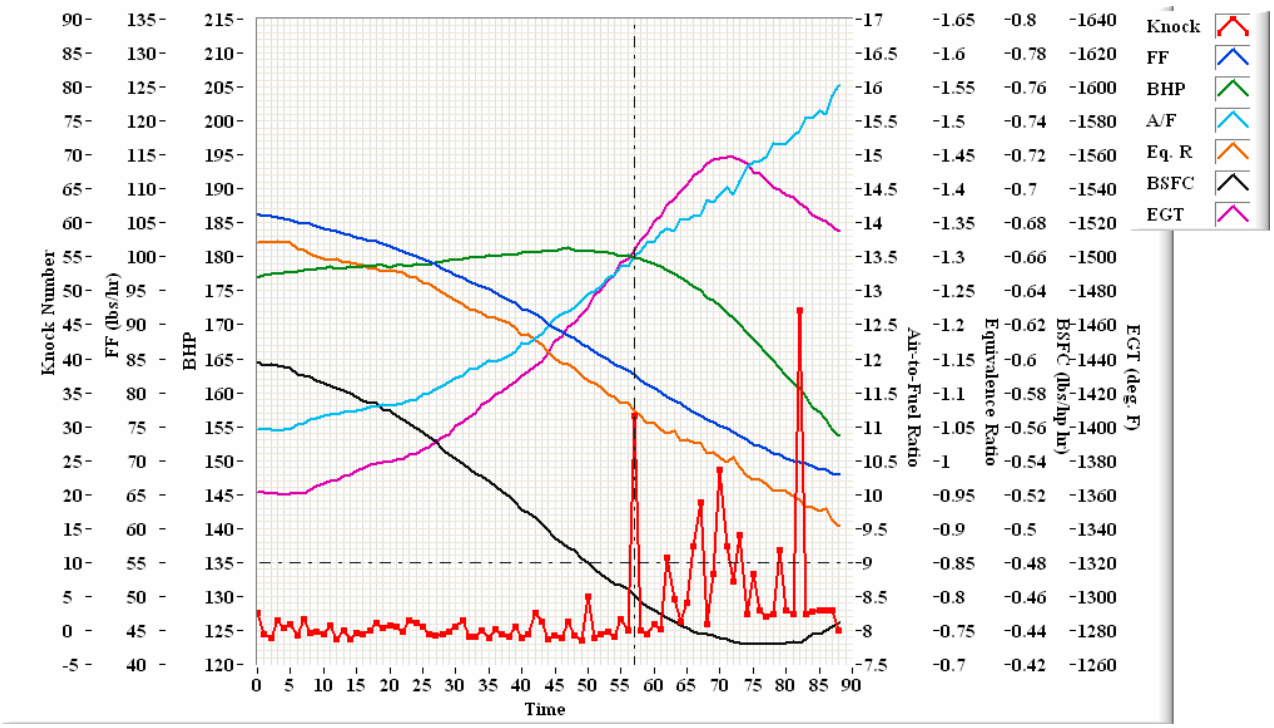


Figure B-136. Blend 35, 2350 rpm

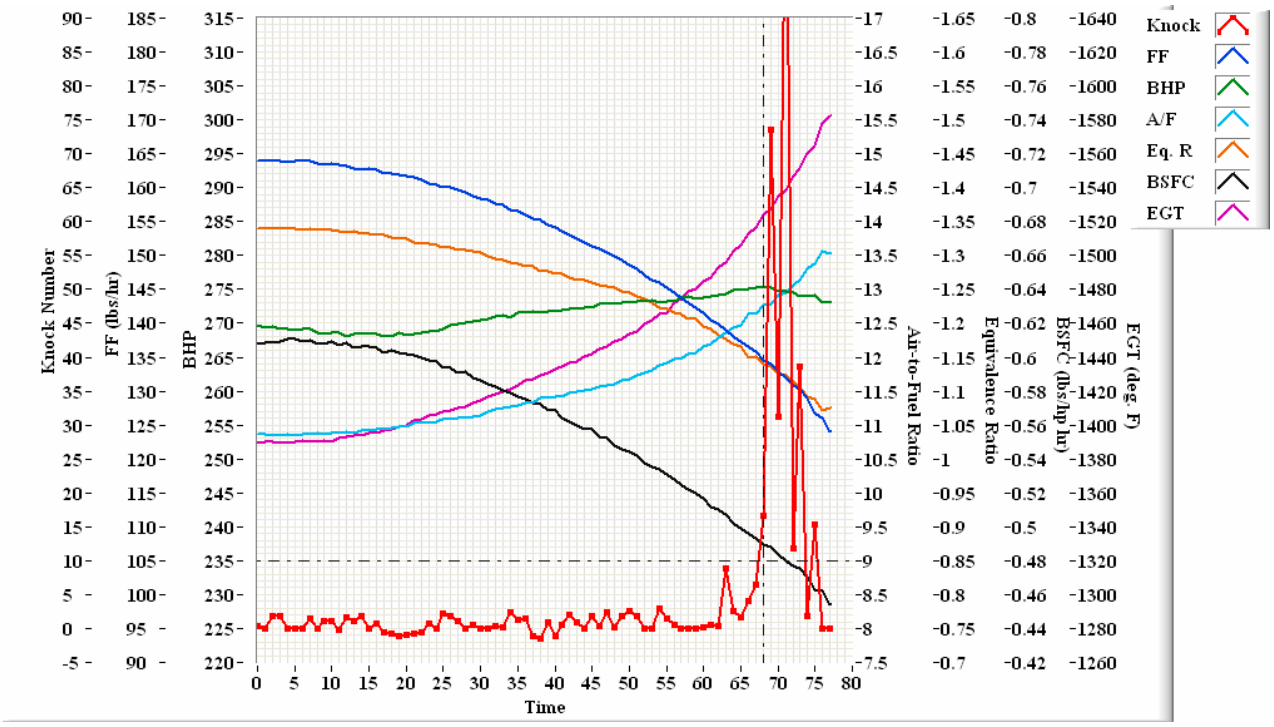


Figure B-137. Blend 36, 2700 rpm

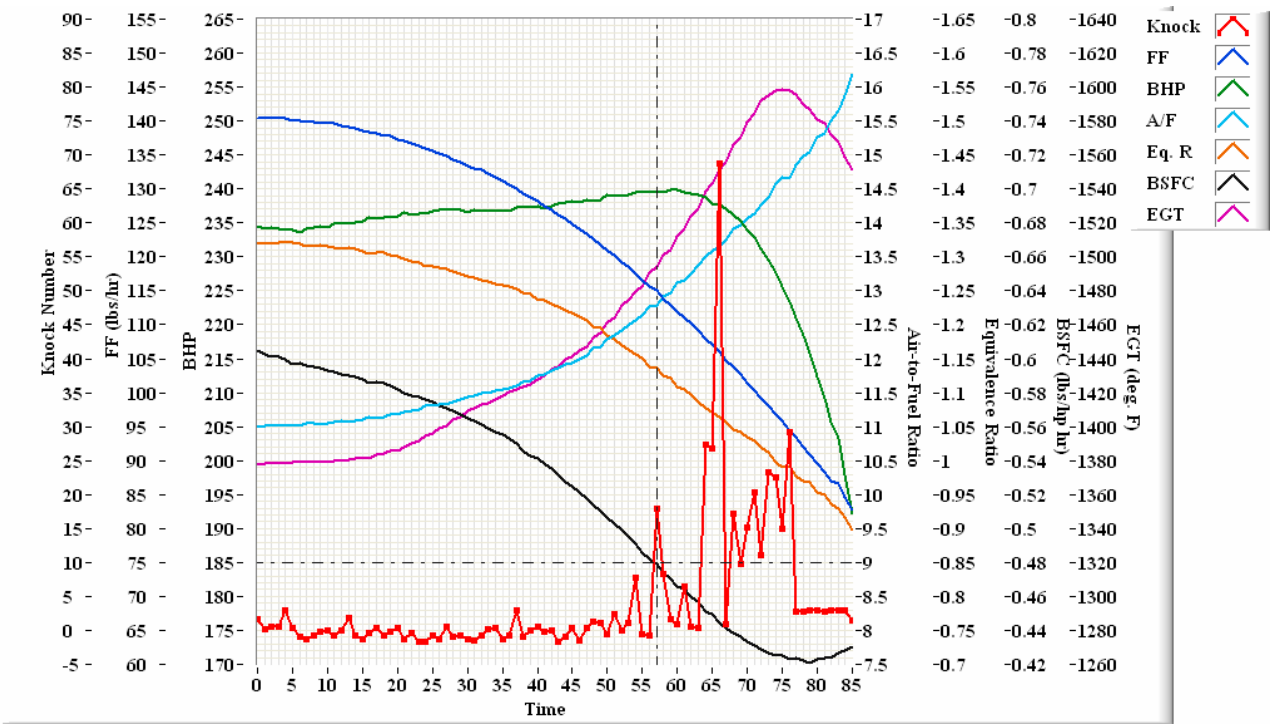


Figure B-138. Blend 36, 2600 rpm

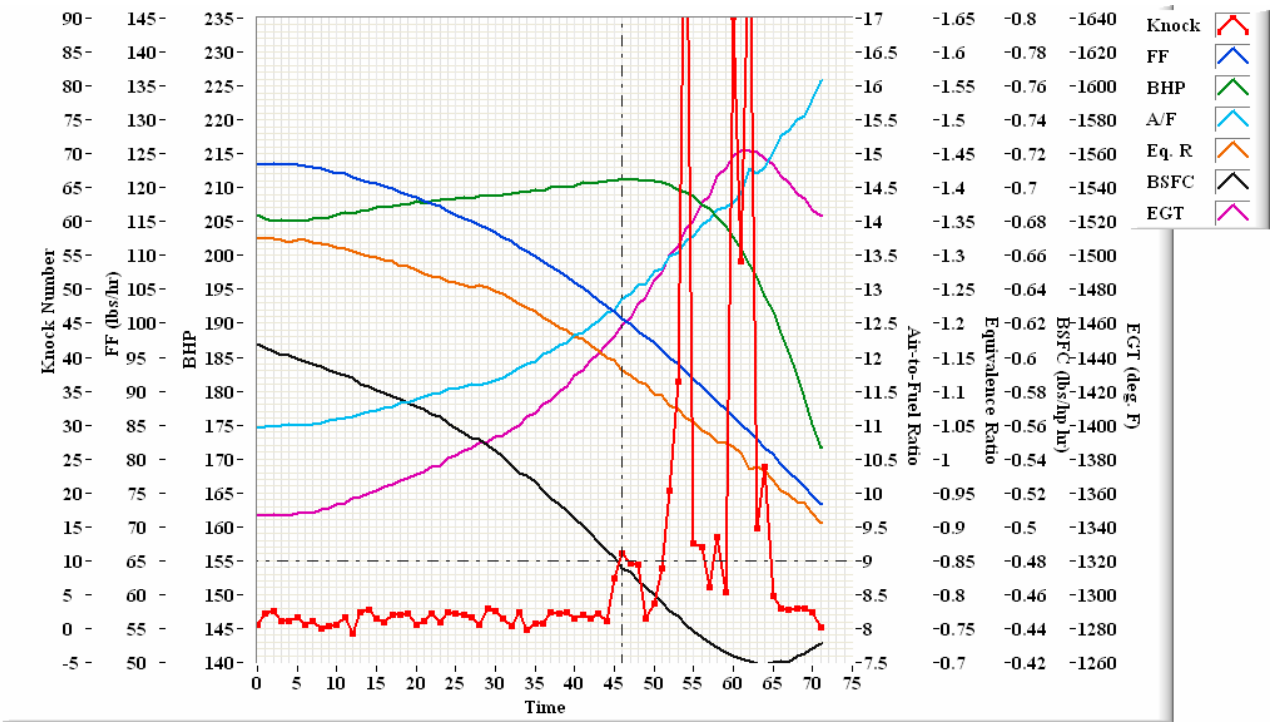


Figure B-139. Blend 36, 2450 rpm

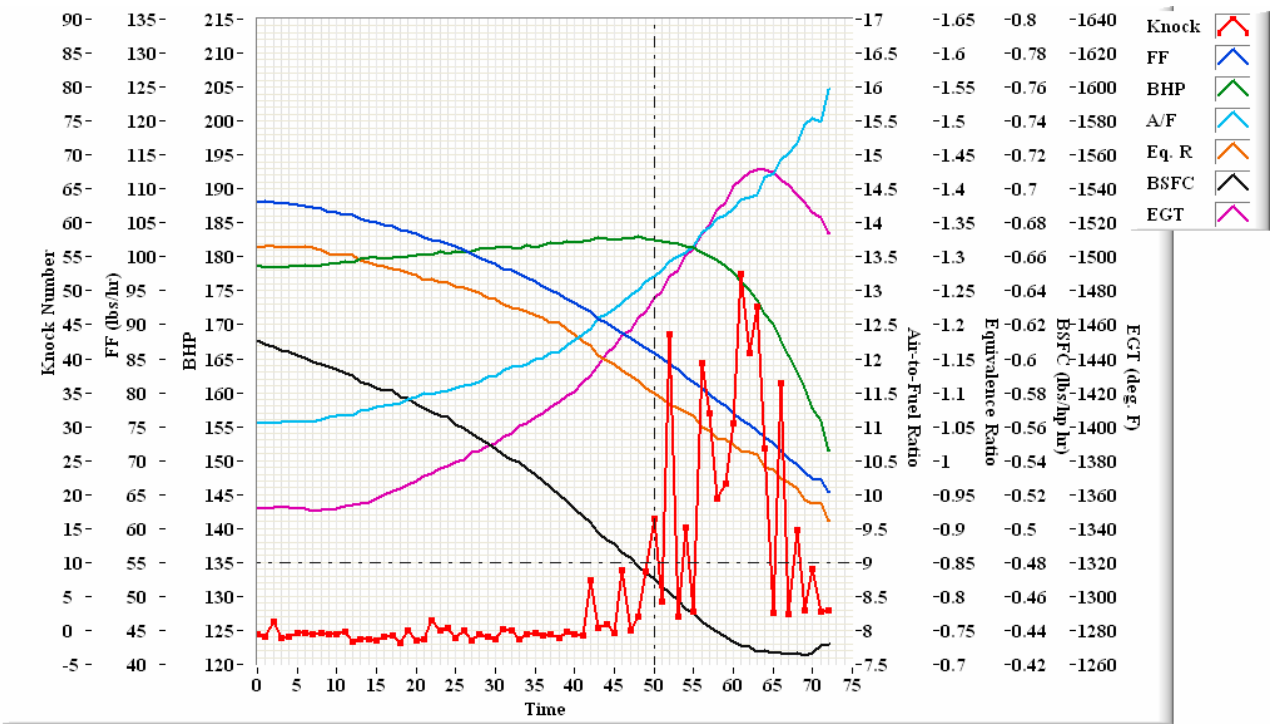


Figure B-140. Blend 36, 2350 rpm

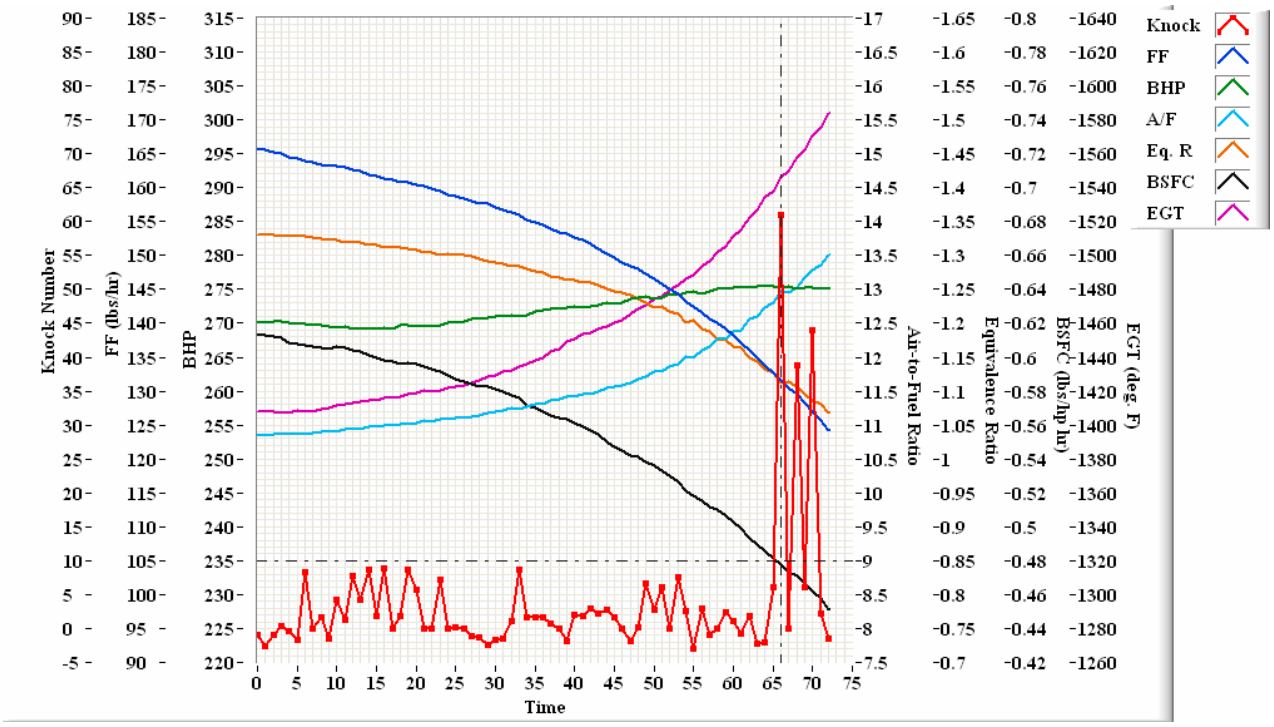


Figure B-141. Blend 37, 2700 rpm

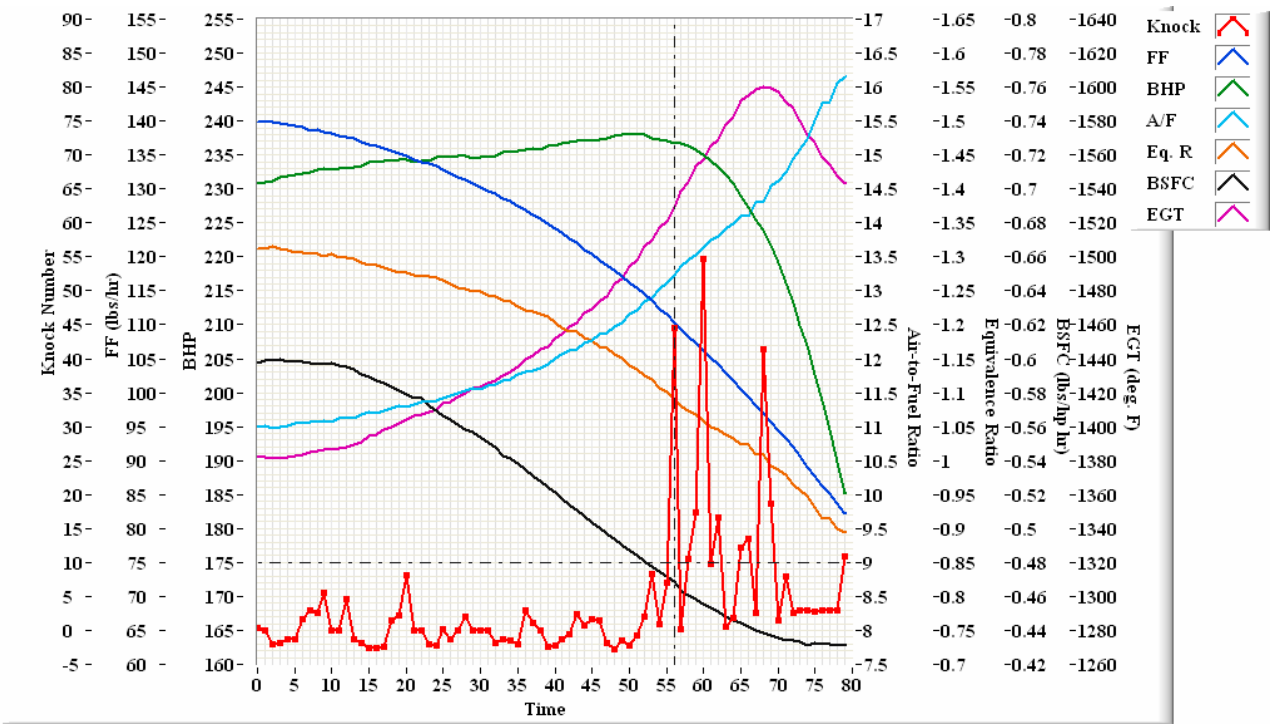


Figure B-142. Blend 37, 2600 rpm

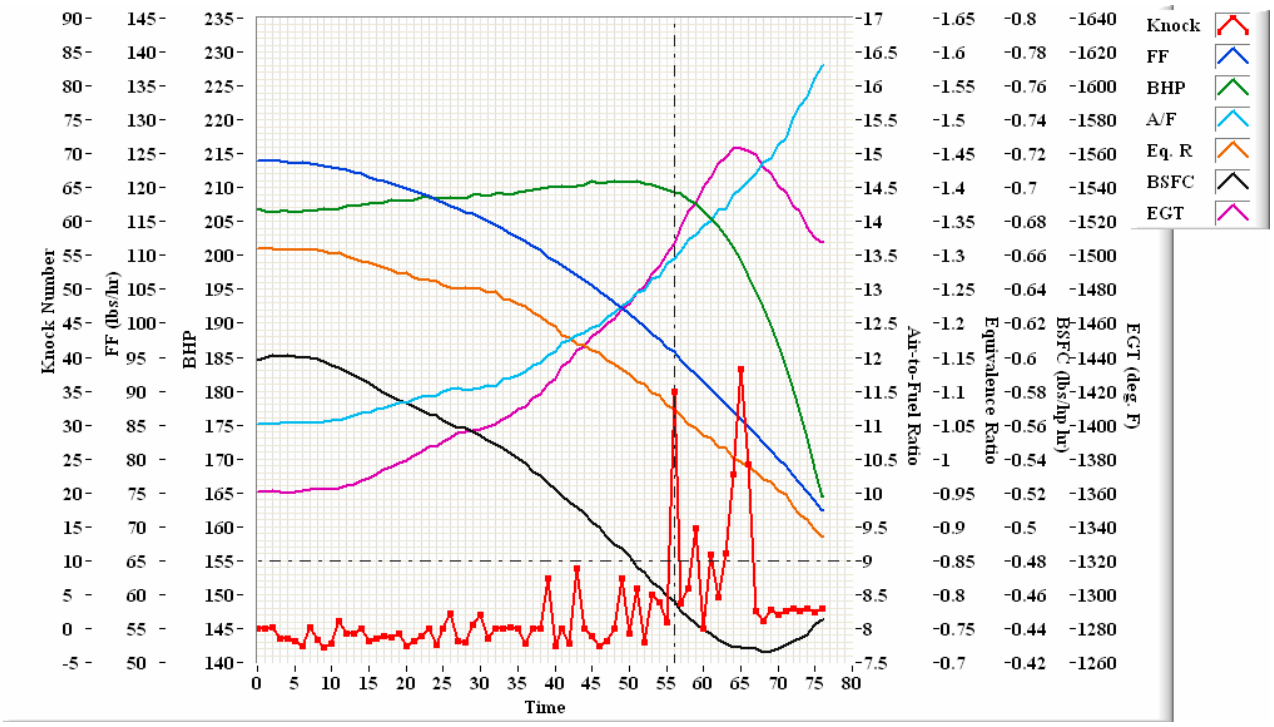


Figure B-143. Blend 37, 2450 rpm

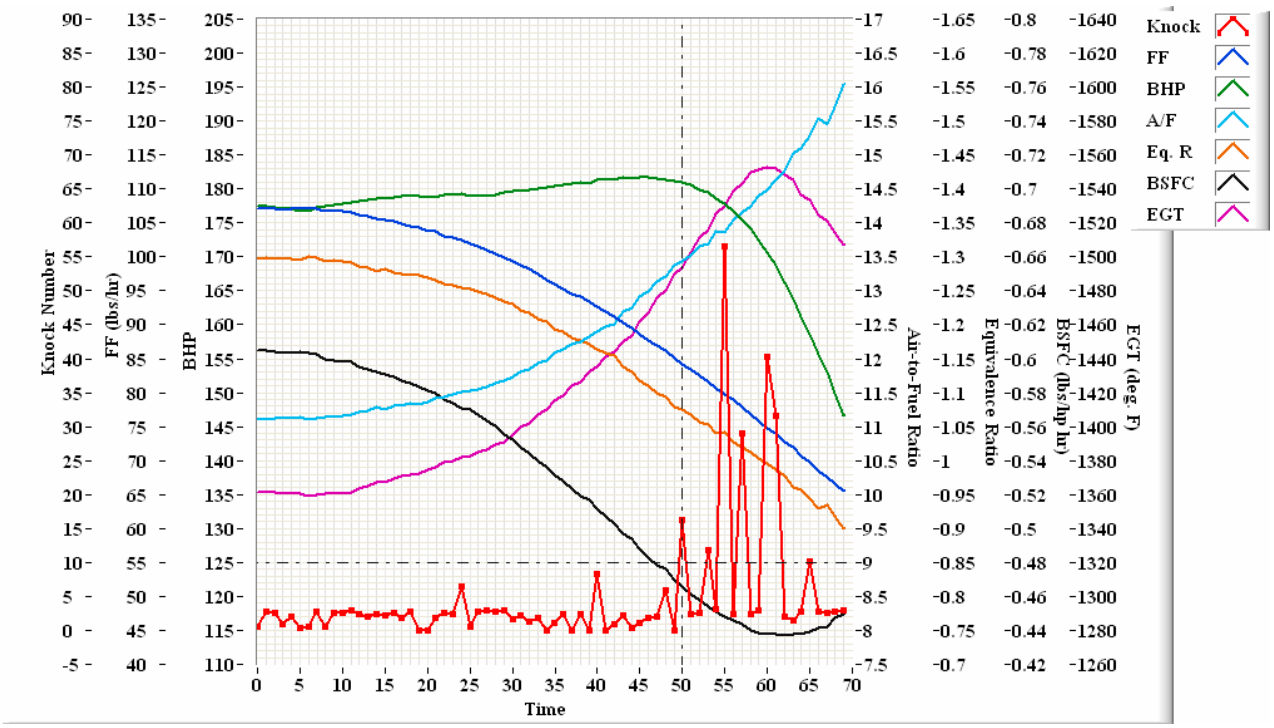


Figure B-144. Blend 37, 2350 rpm

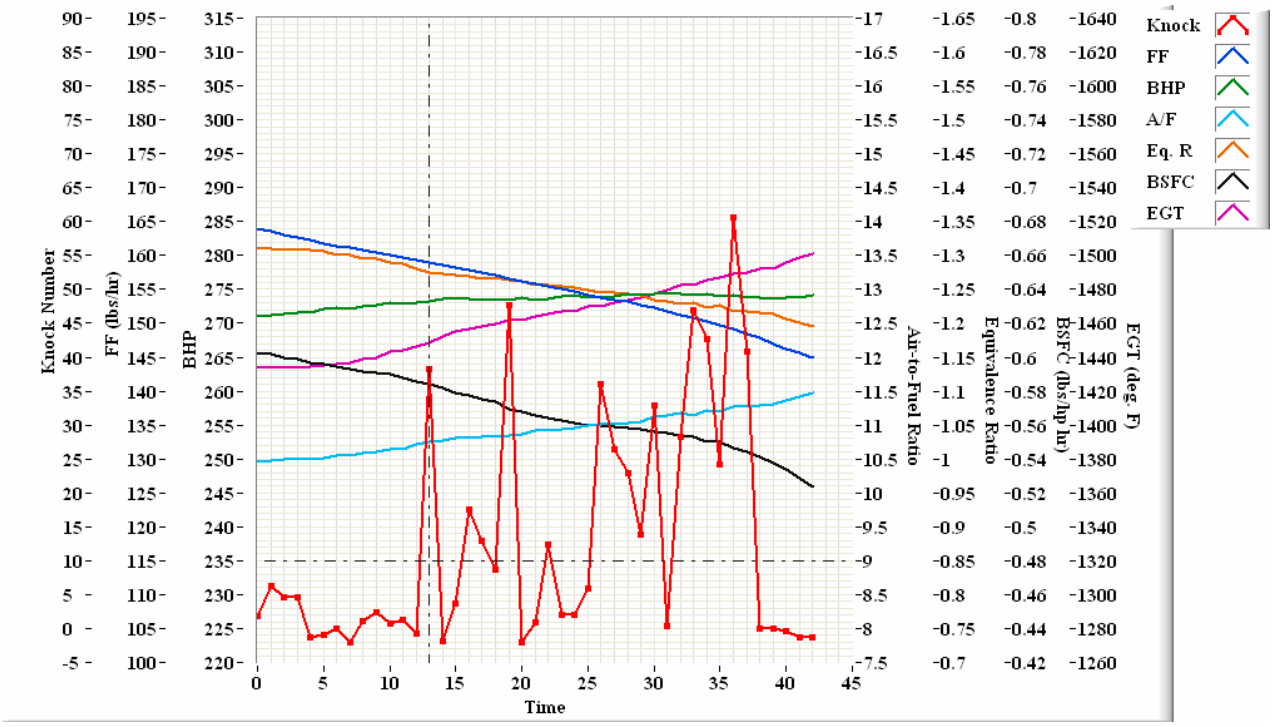


Figure B-145. Blend 38, 2700 rpm

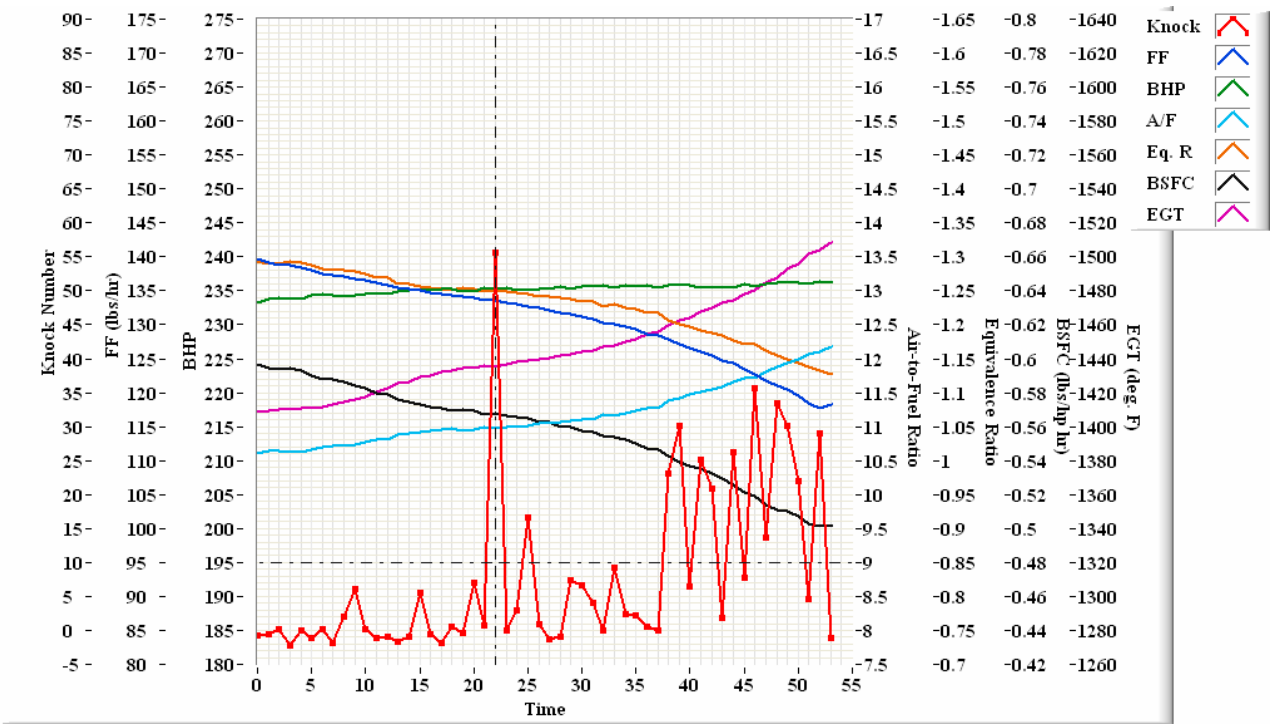


Figure B-146. Blend 38, 2600 rpm

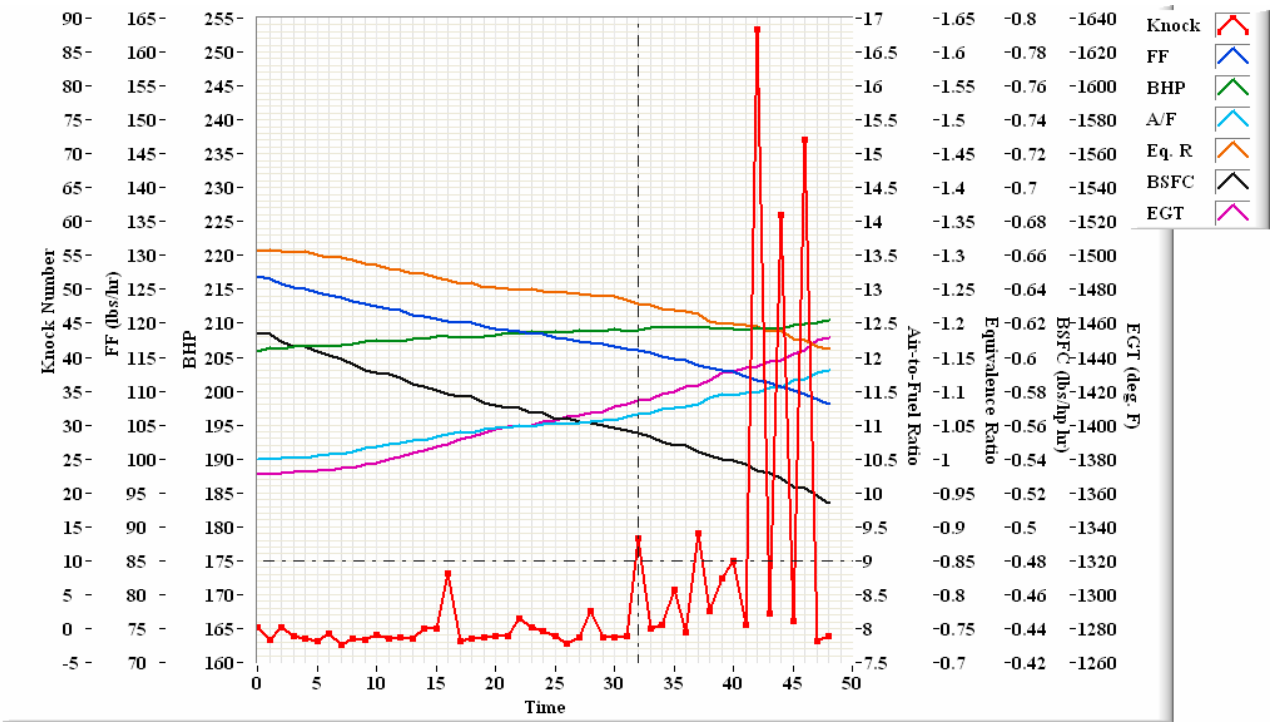


Figure B-147. Blend 38, 2450 rpm

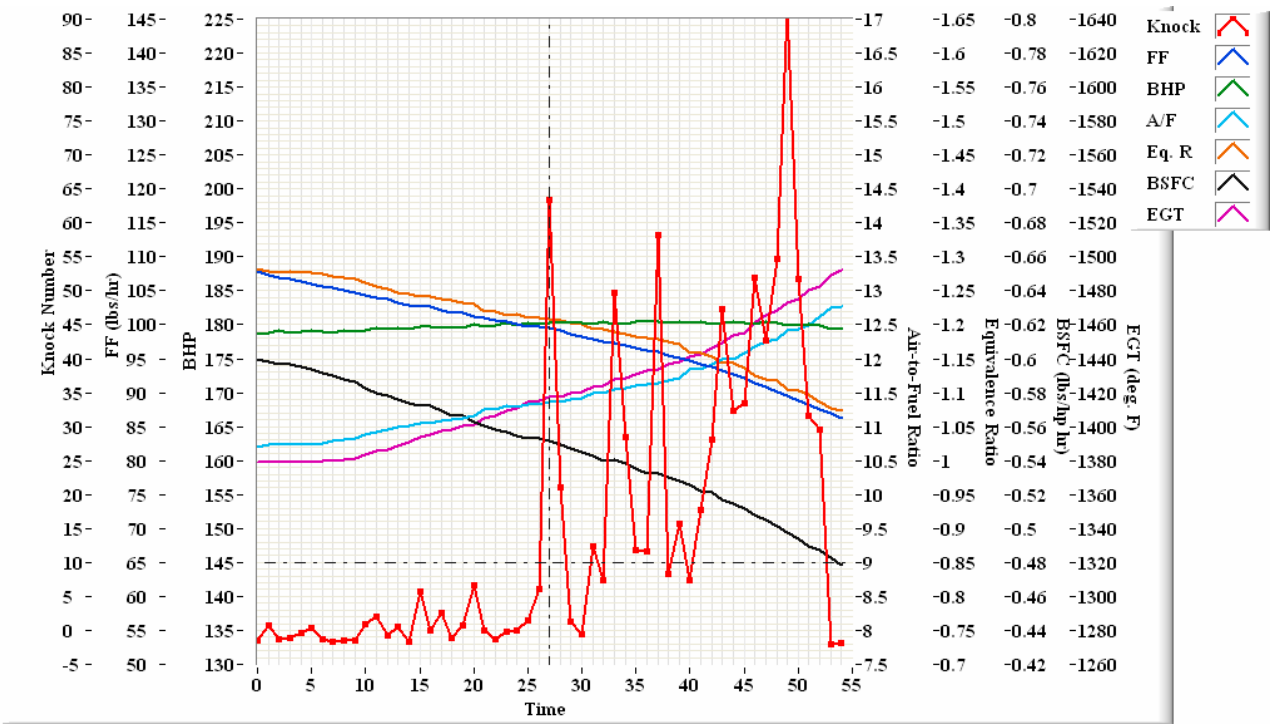


Figure B-148. Blend 38, 2350 rpm

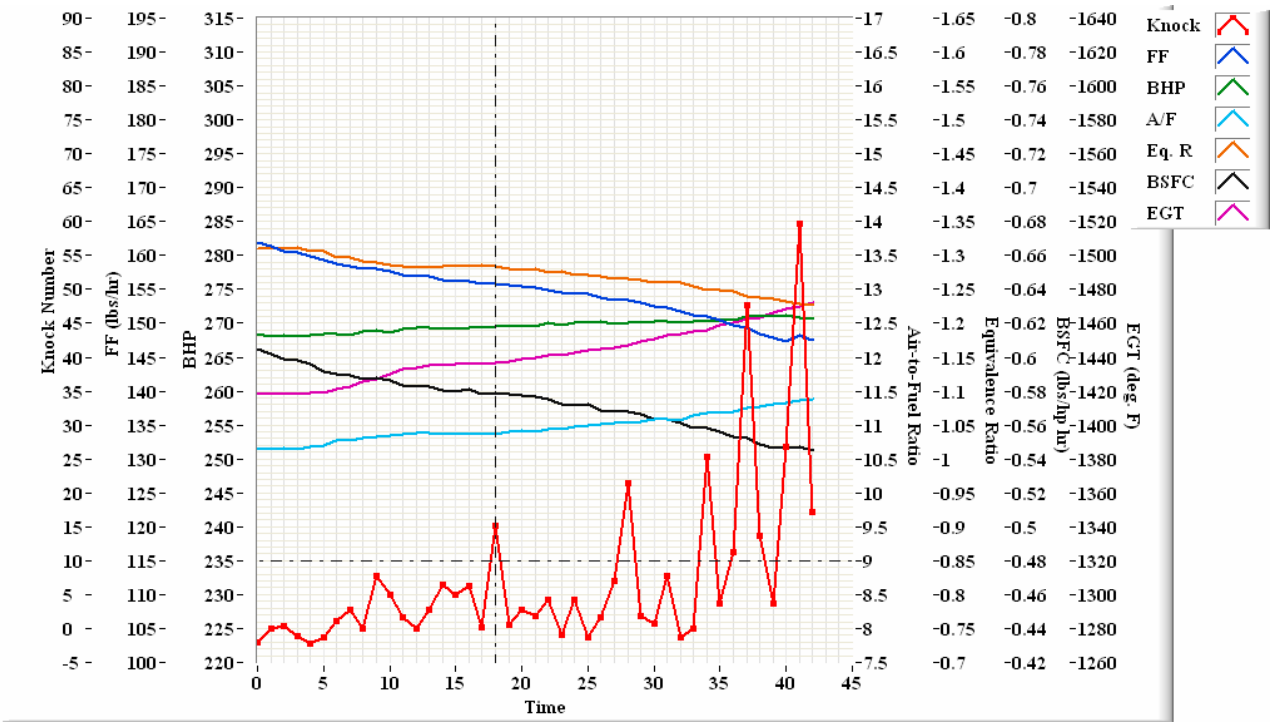


Figure B-149. Blend 39, 2700 rpm

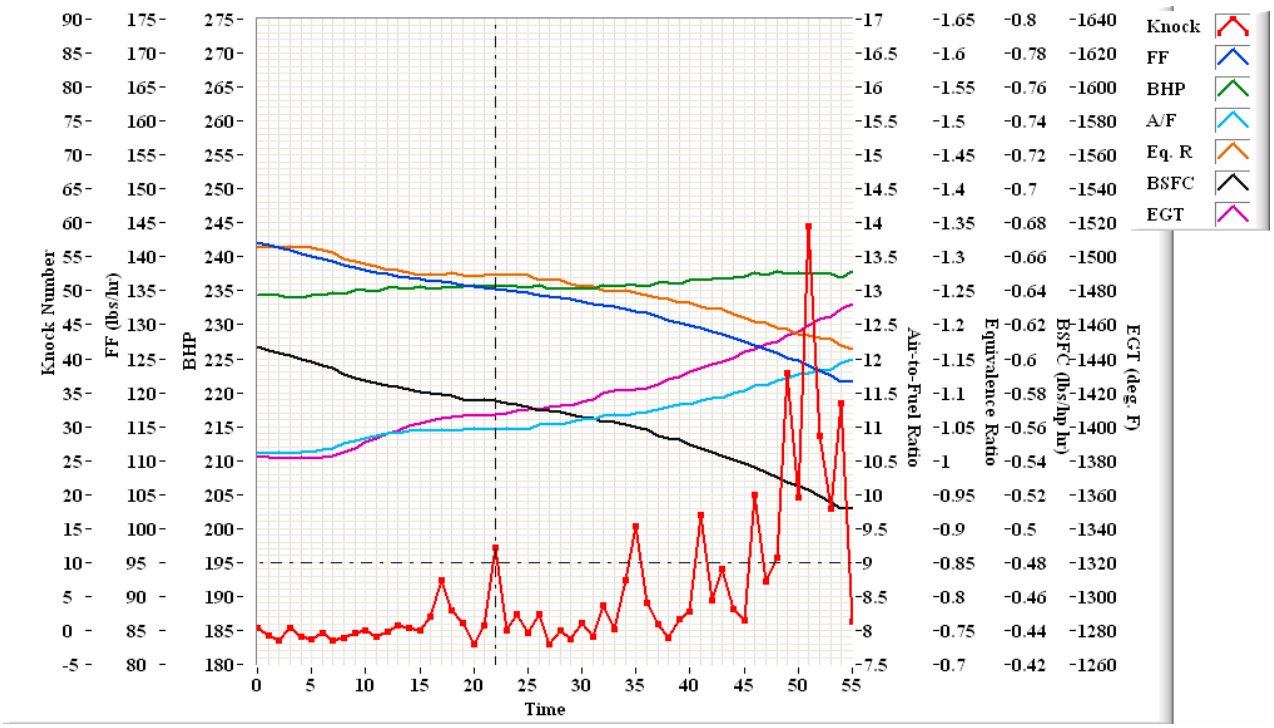


Figure B-150. Blend 39, 2600 rpm

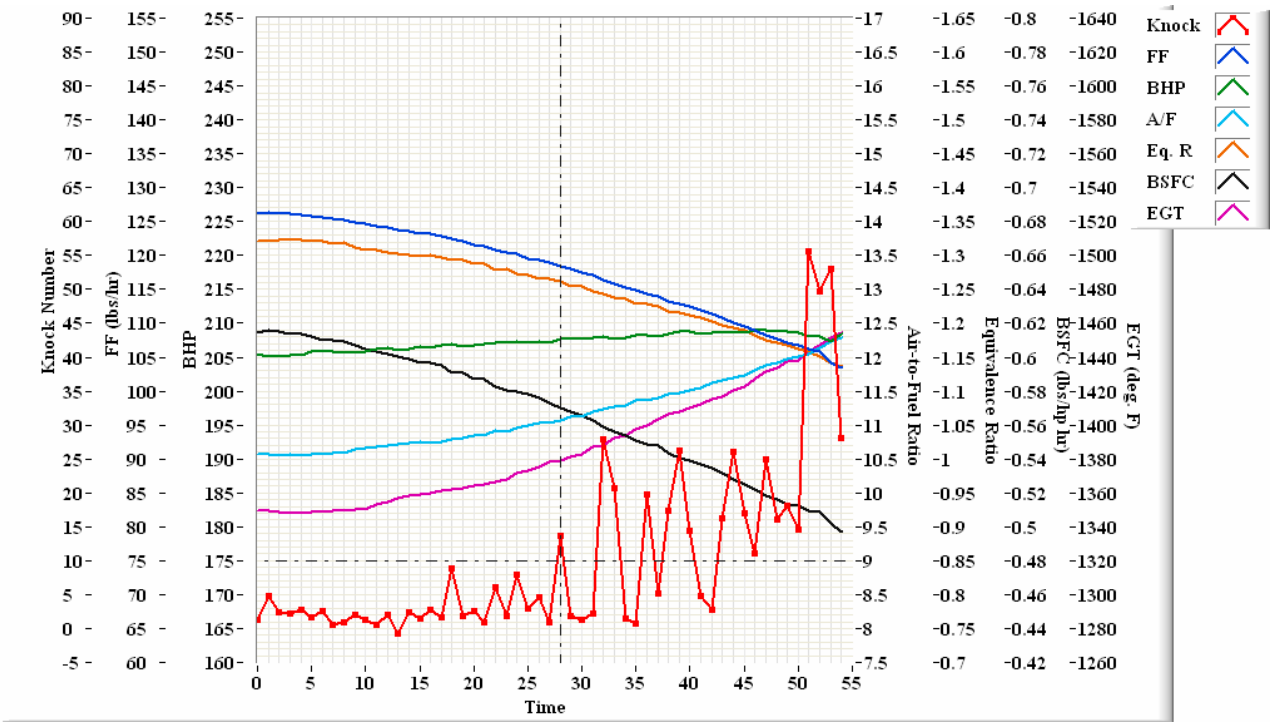


Figure B-151. Blend 39, 2450 rpm

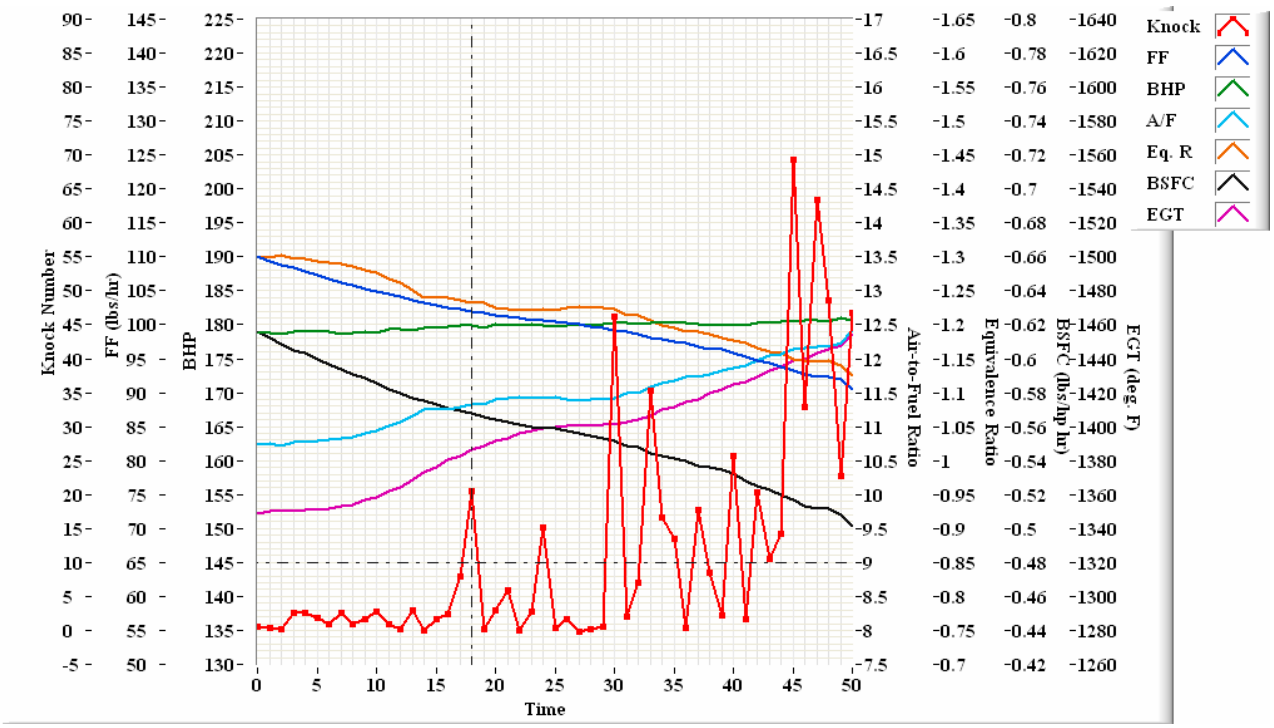


Figure B-152. Blend 39, 2350 rpm

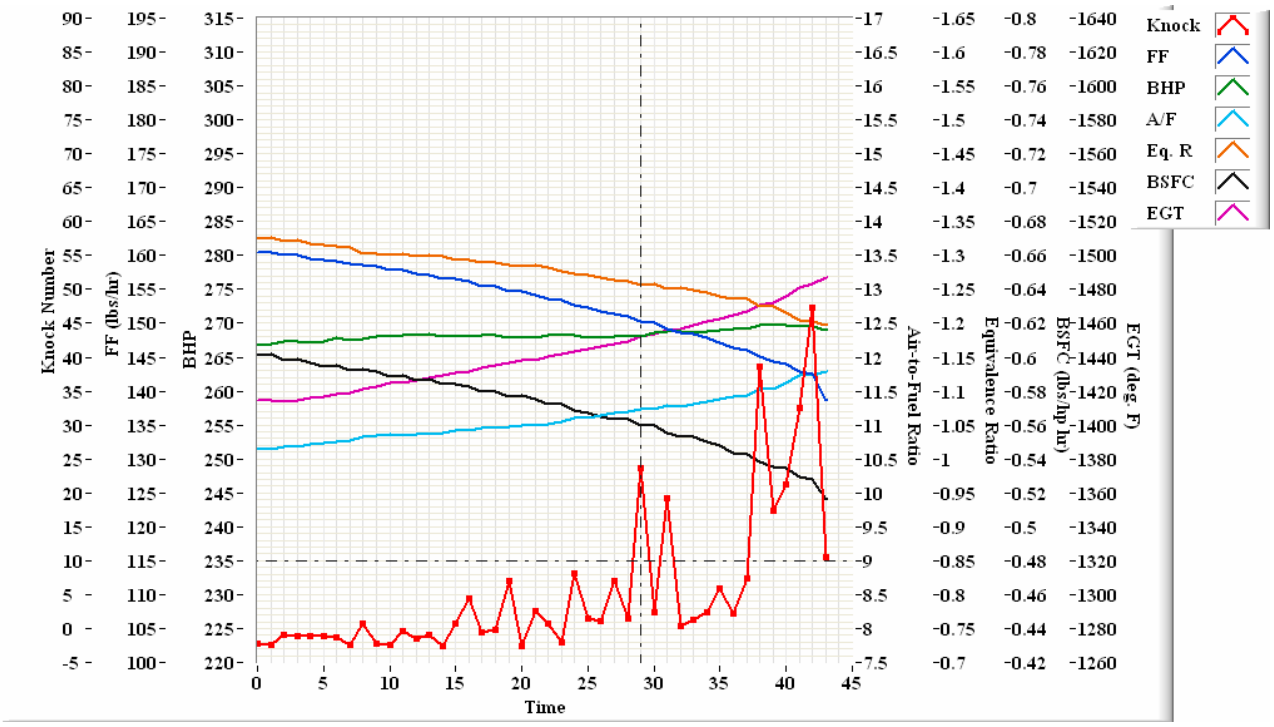


Figure B-153. Blend 40, 2700 rpm

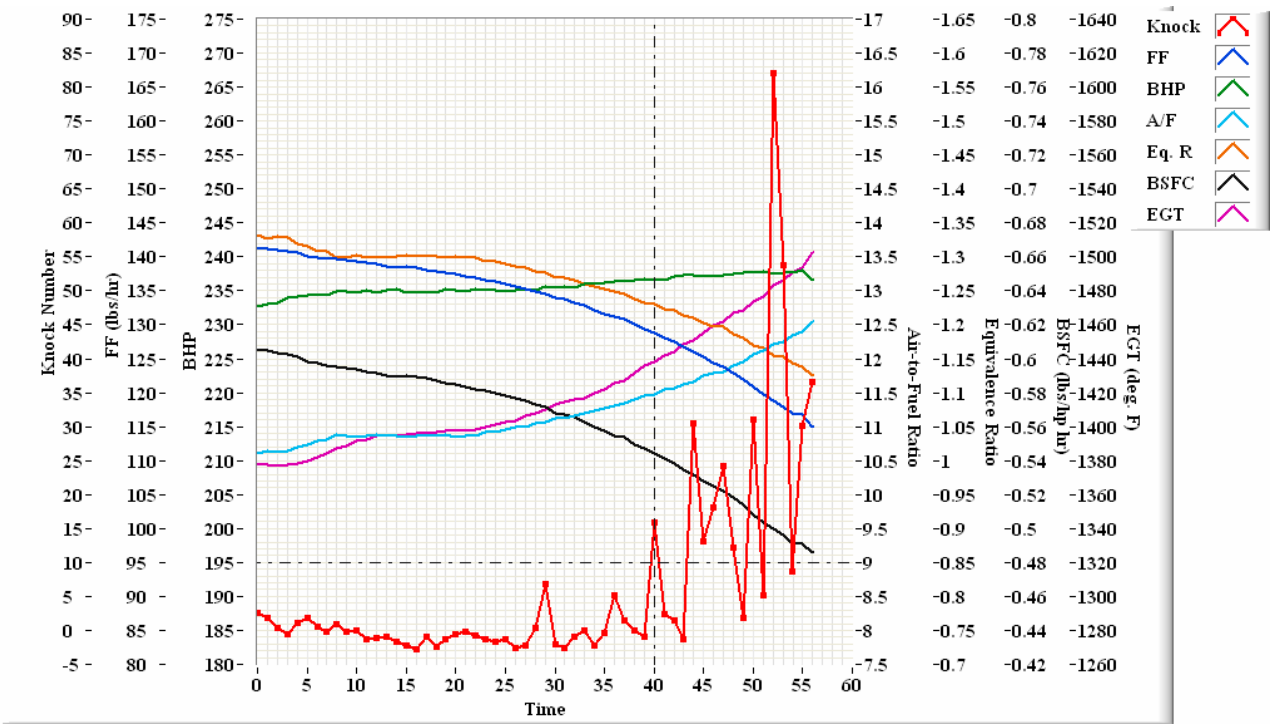


Figure B-154. Blend 40, 2600 rpm

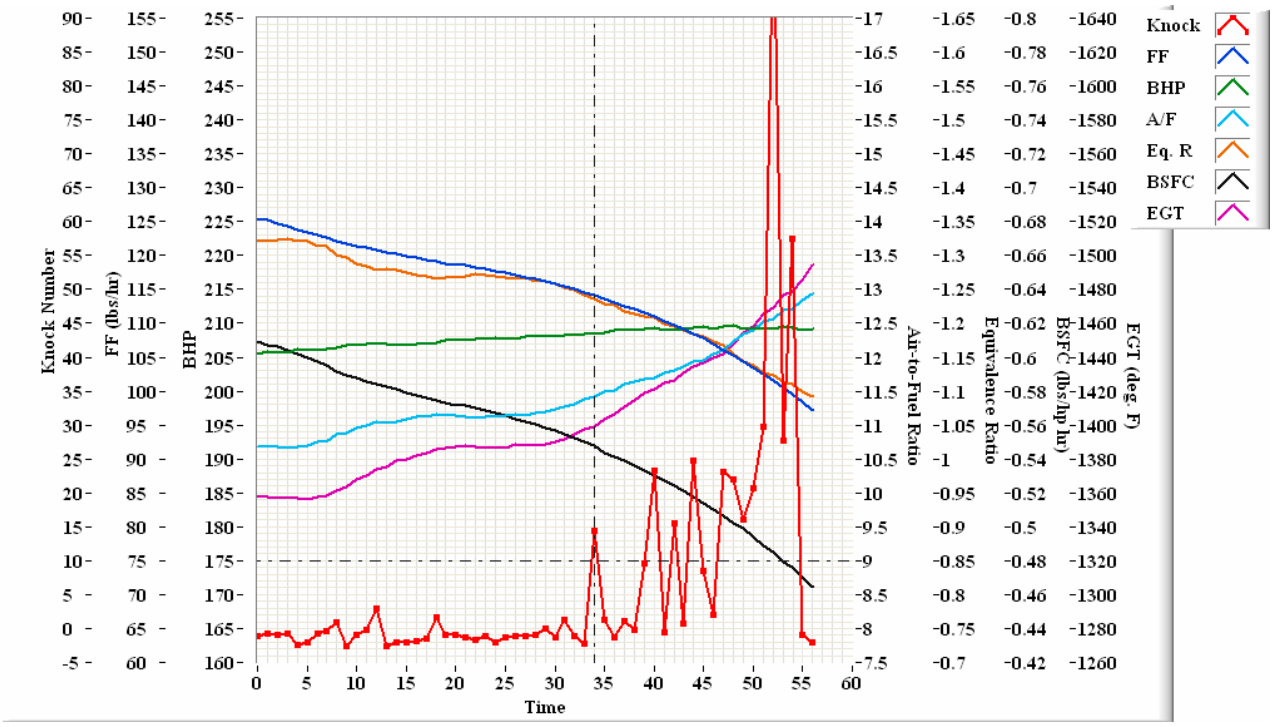


Figure B-155. Blend 40, 2450 rpm

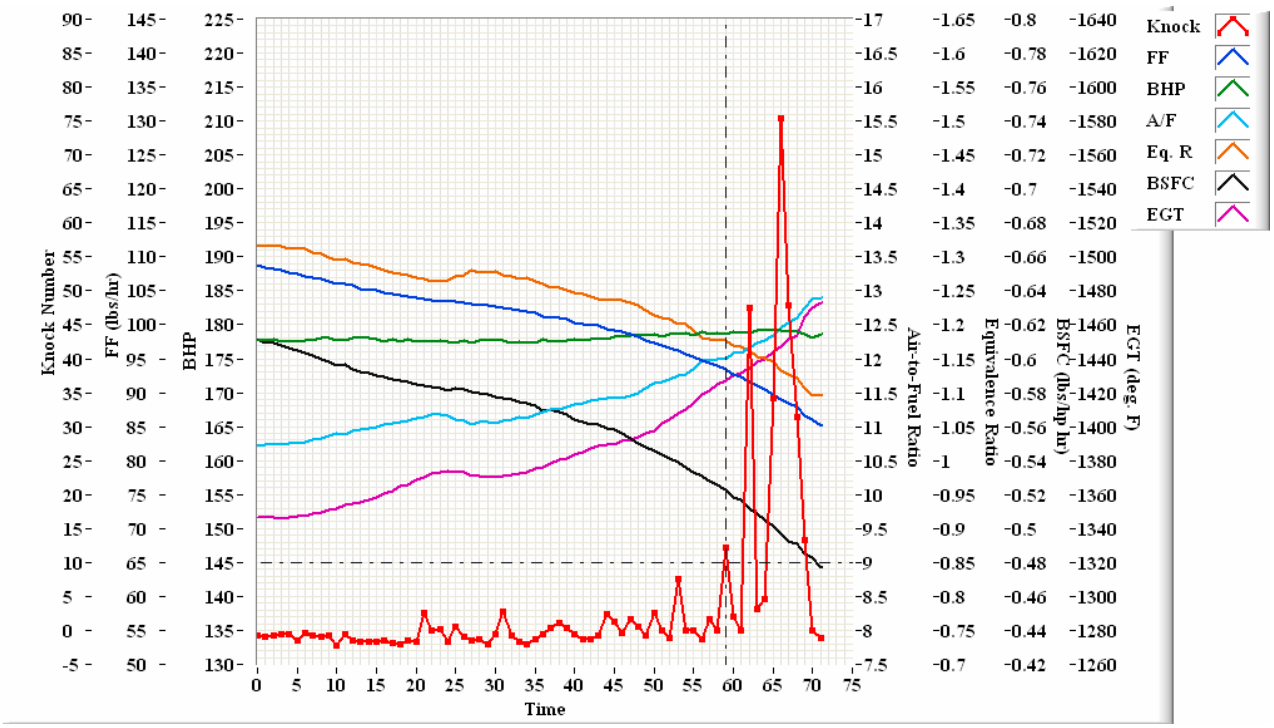


Figure B-156. Blend 40, 2350 rpm

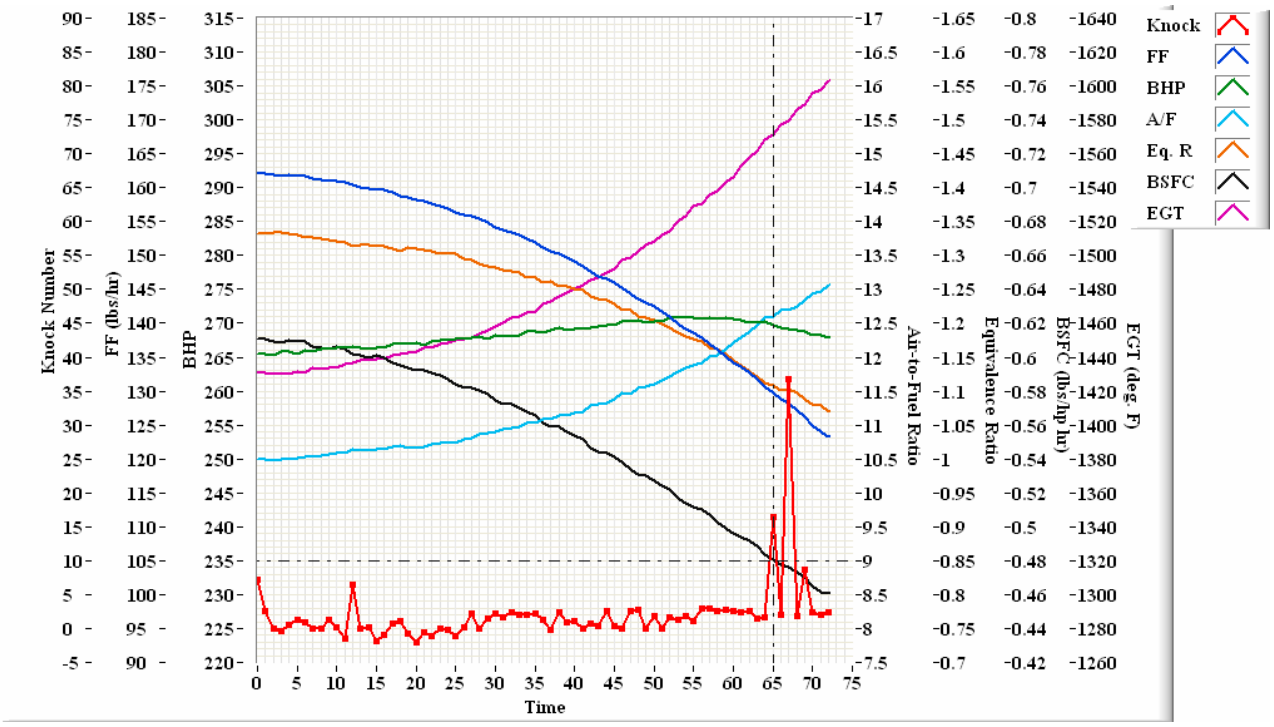


Figure B-157. Blend 41, 2700 rpm

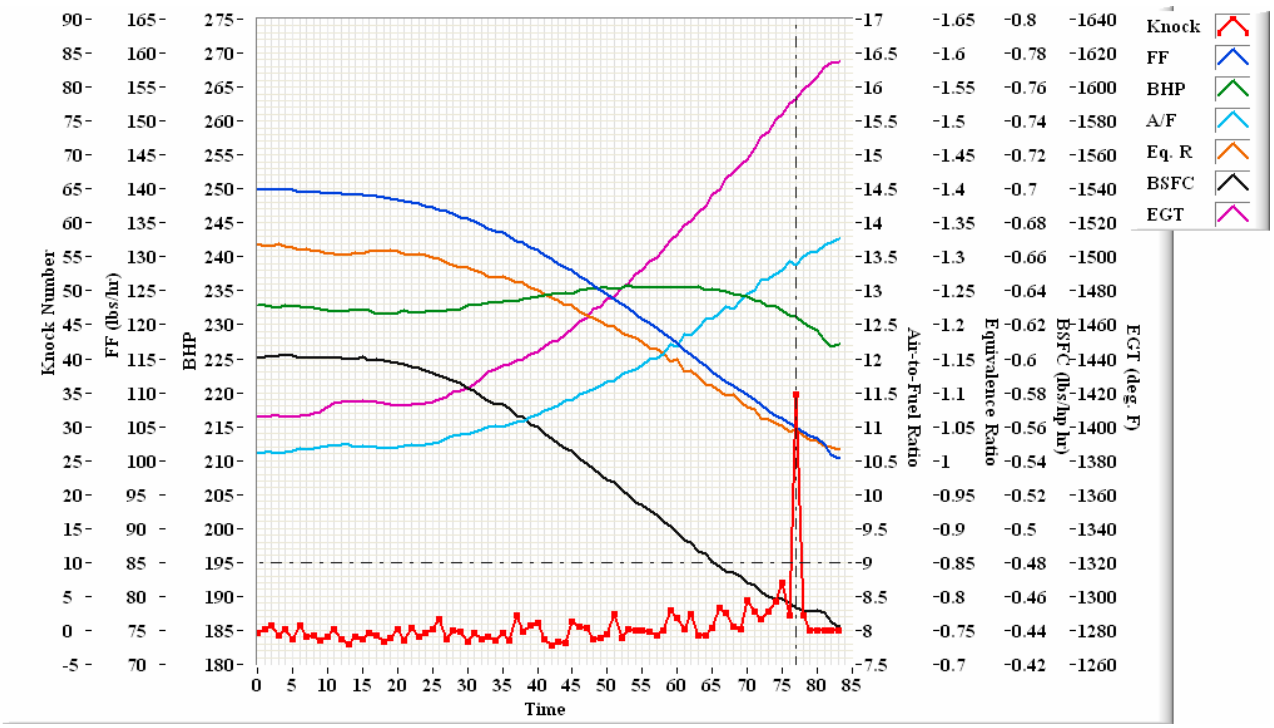


Figure B-158. Blend 41, 2600 rpm

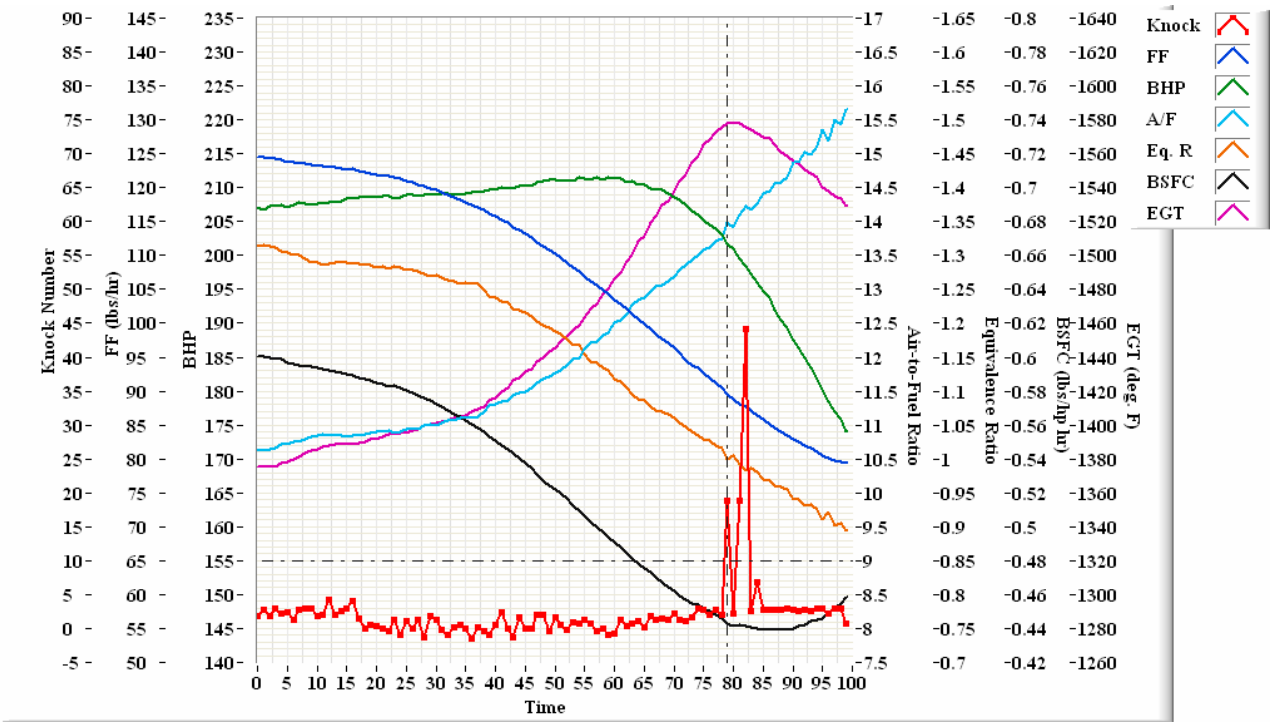


Figure B-159. Blend 41, 2450 rpm

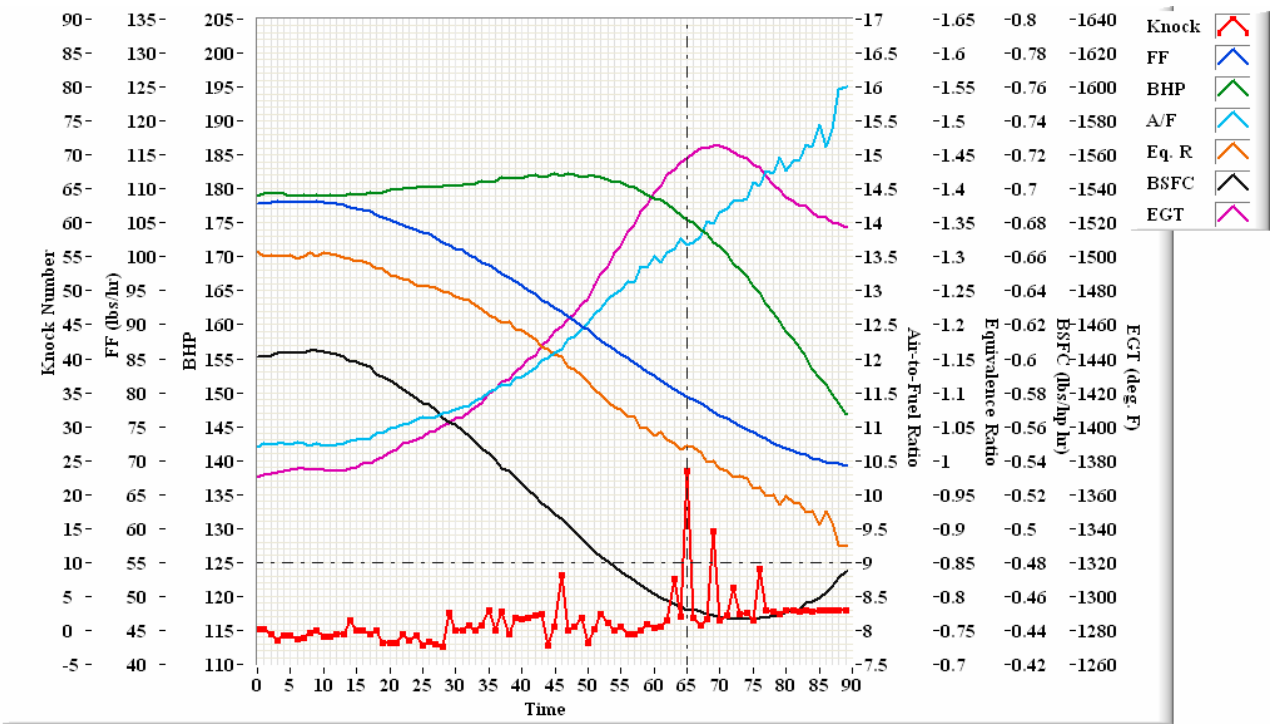


Figure B-160. Blend 41, 2350 rpm

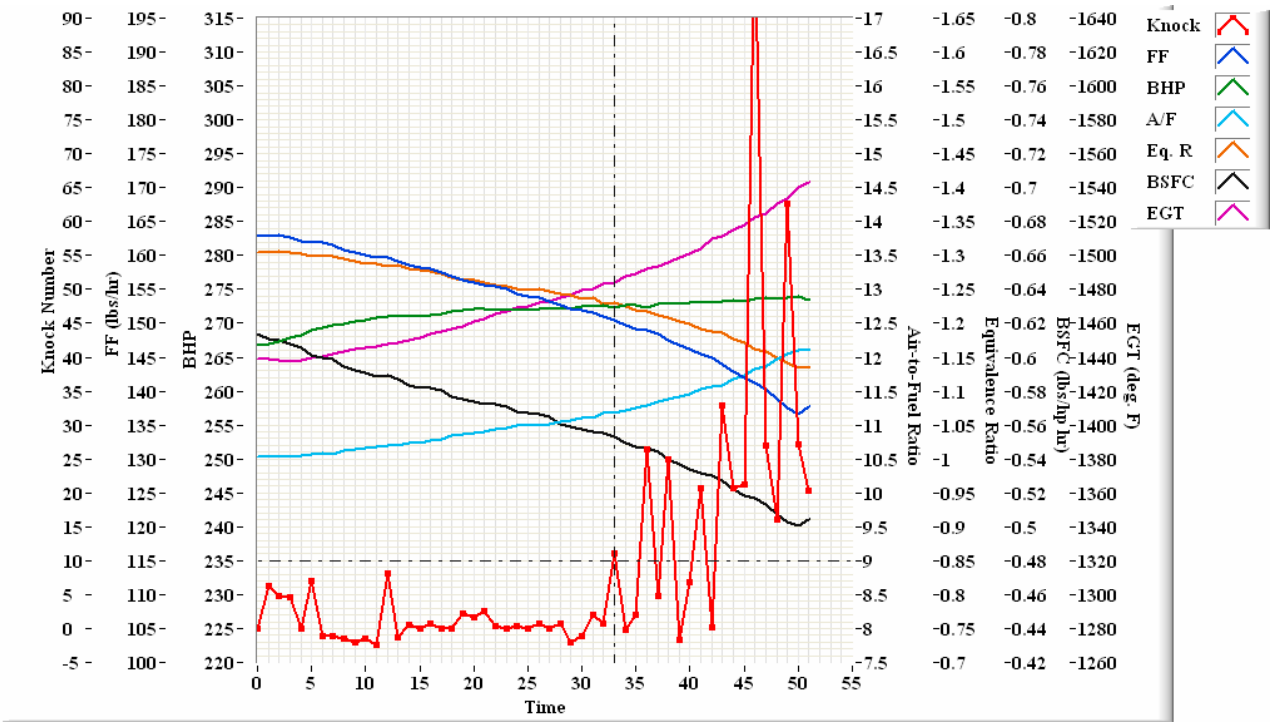


Figure B-161. Blend 42, 2700 rpm

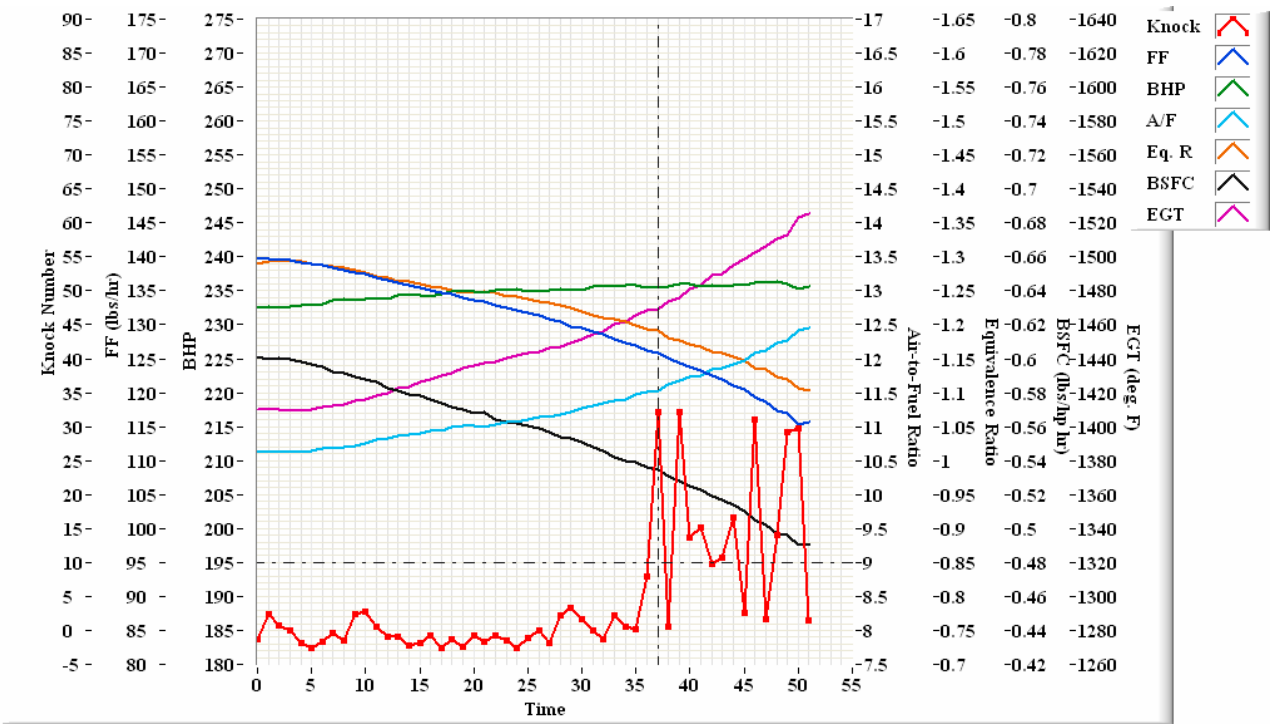


Figure B-162. Blend 42, 2600 rpm

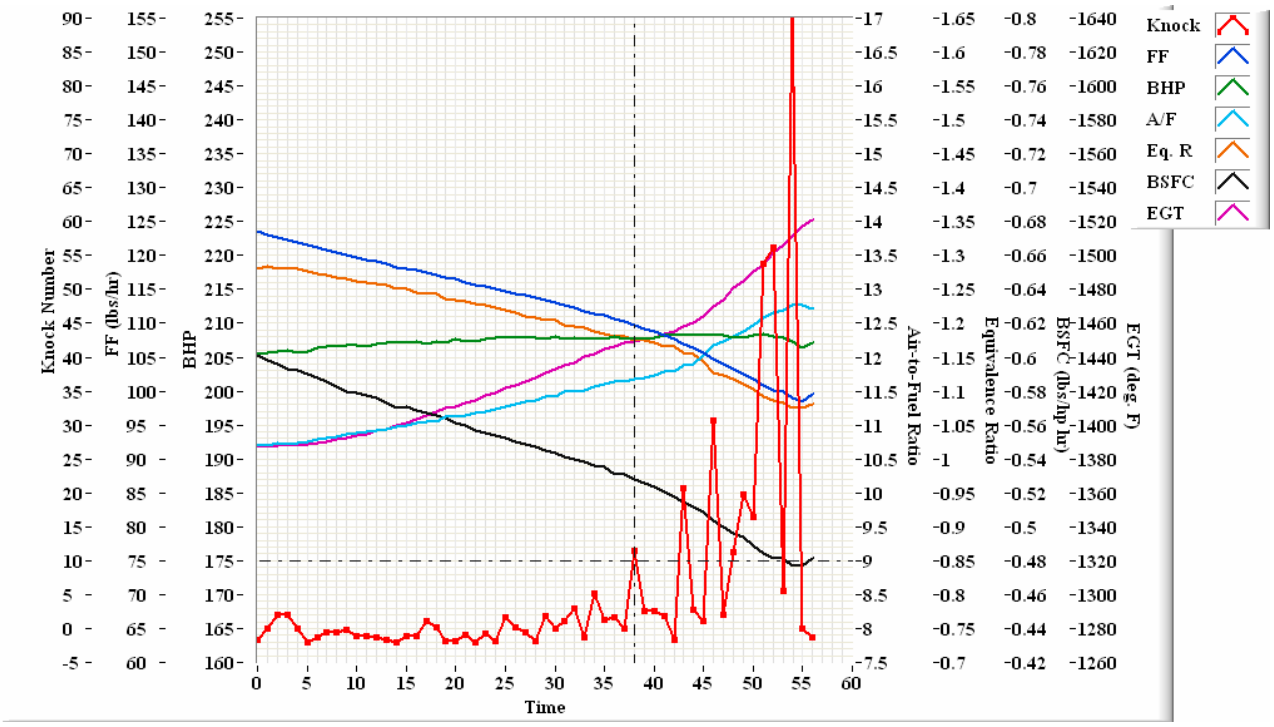


Figure B-163. Blend 42, 2450 rpm

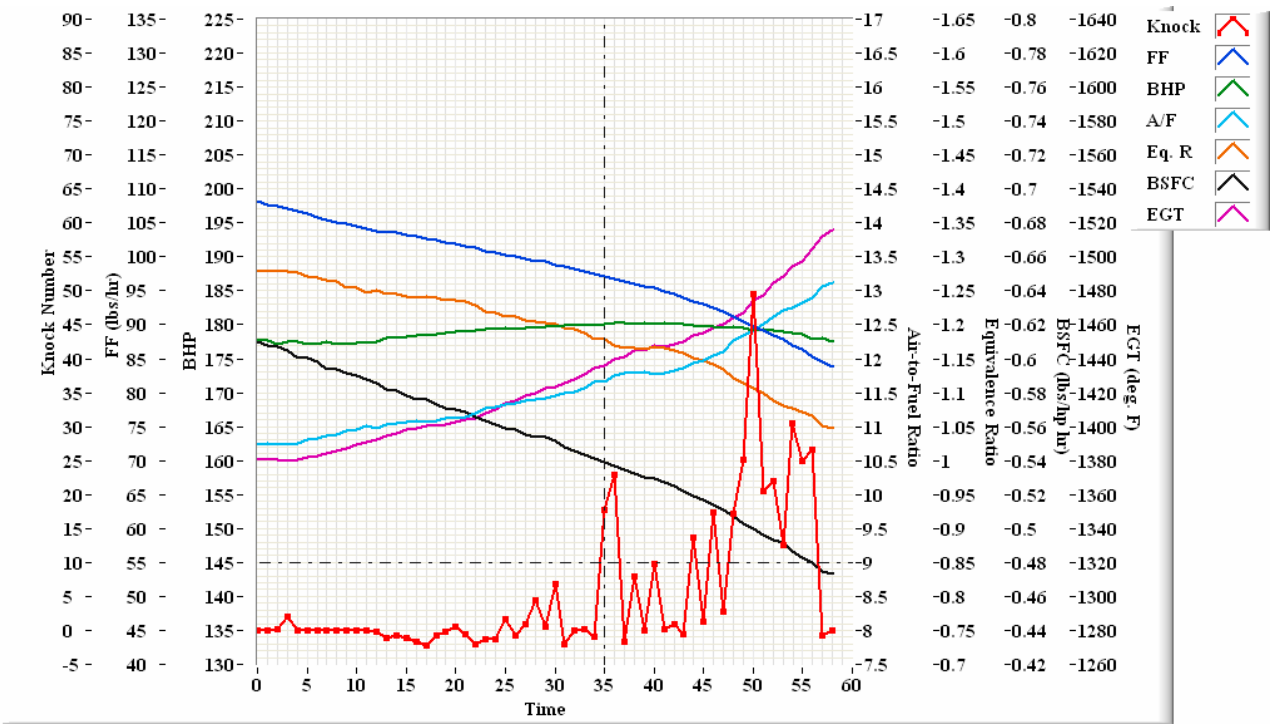


Figure B-164. Blend 42, 2350 rpm

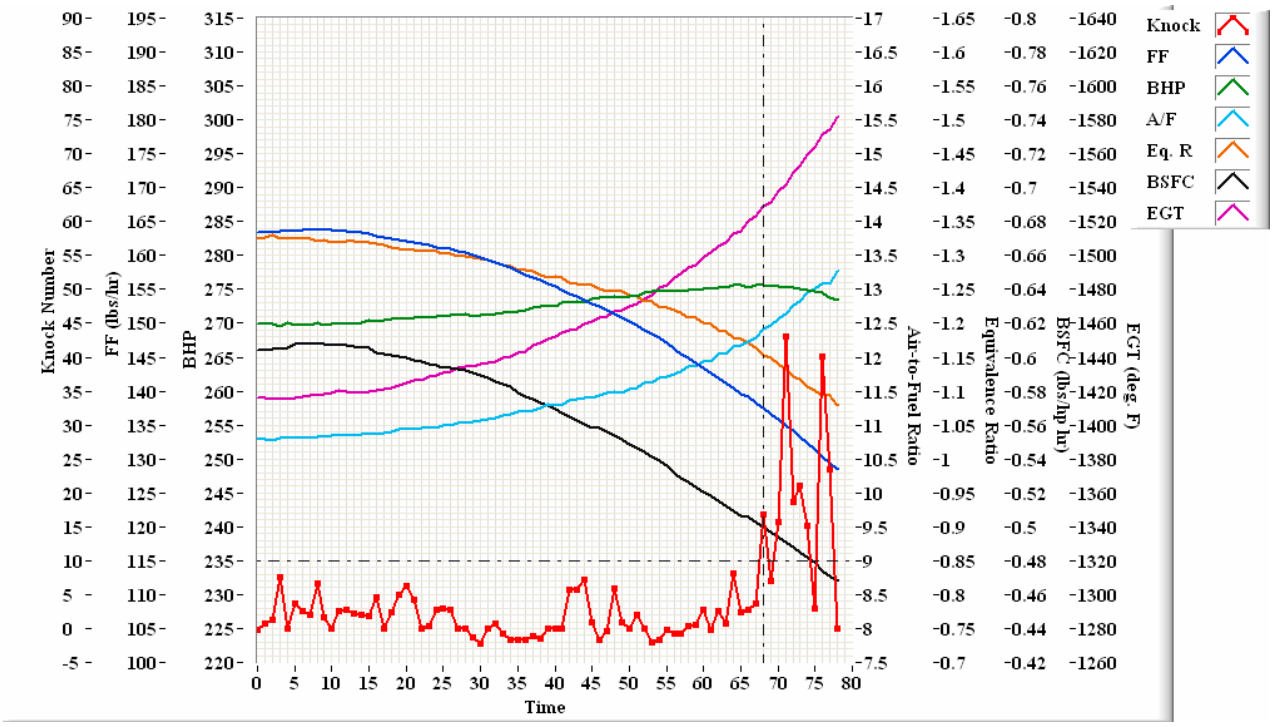


Figure B-165. Blend 43, 2700 rpm

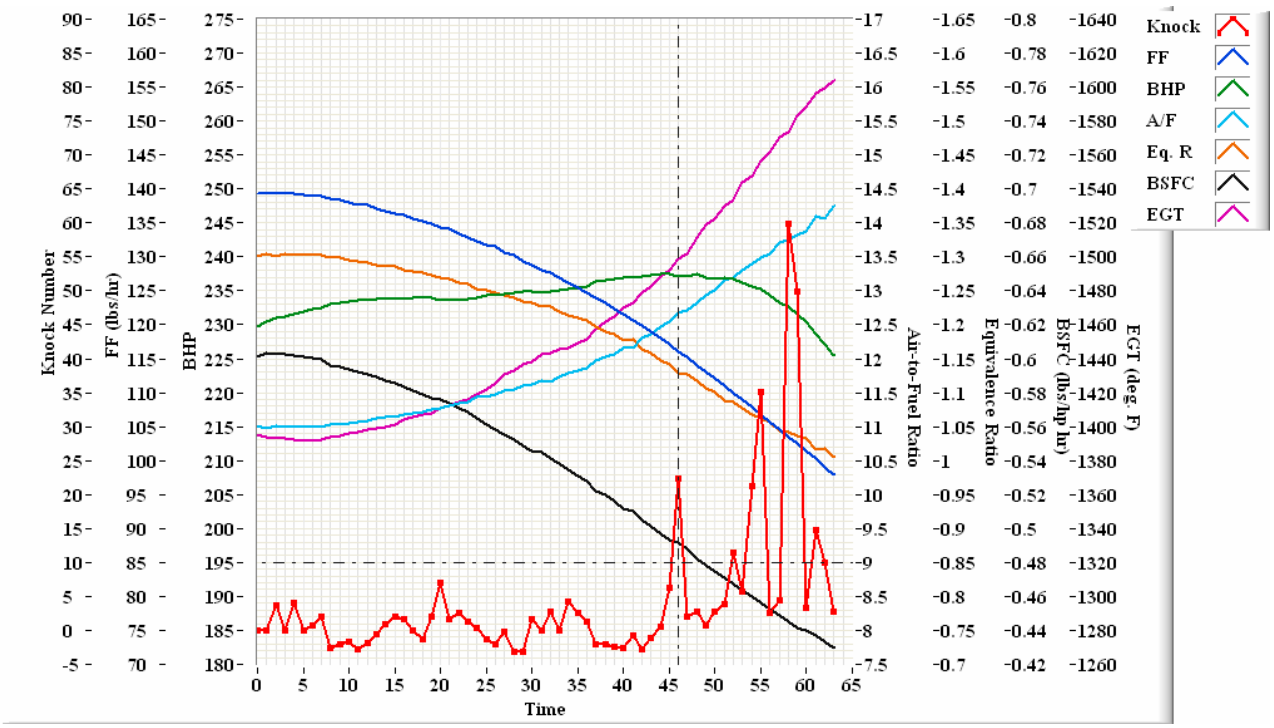


Figure B-166. Blend 43, 2600 rpm

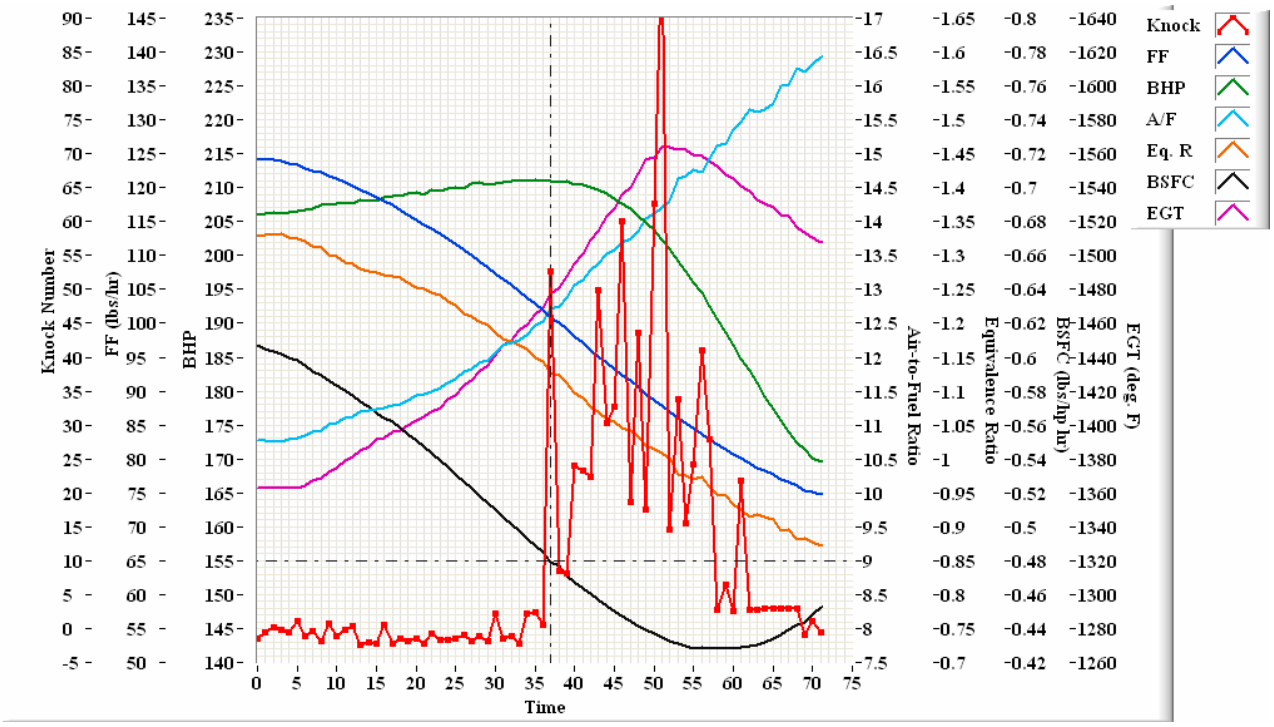


Figure B-167. Blend 43, 2450 rpm

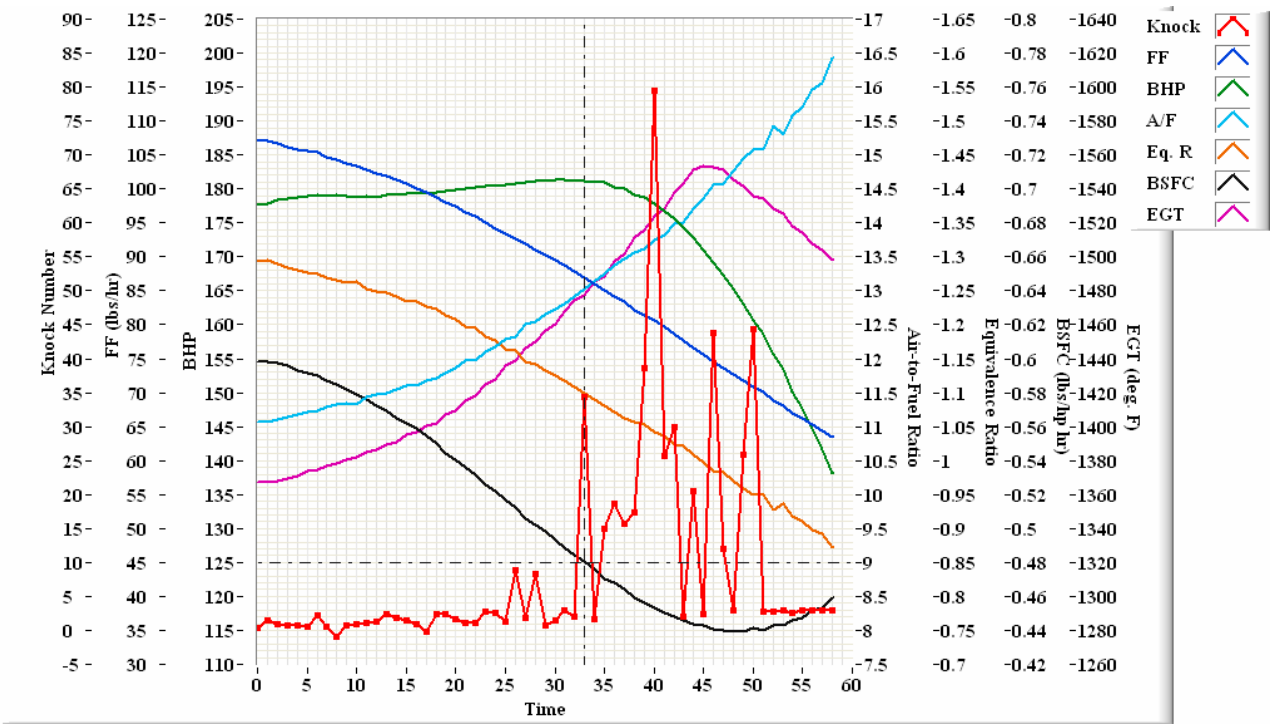


Figure B-168. Blend 43, 2350 rpm

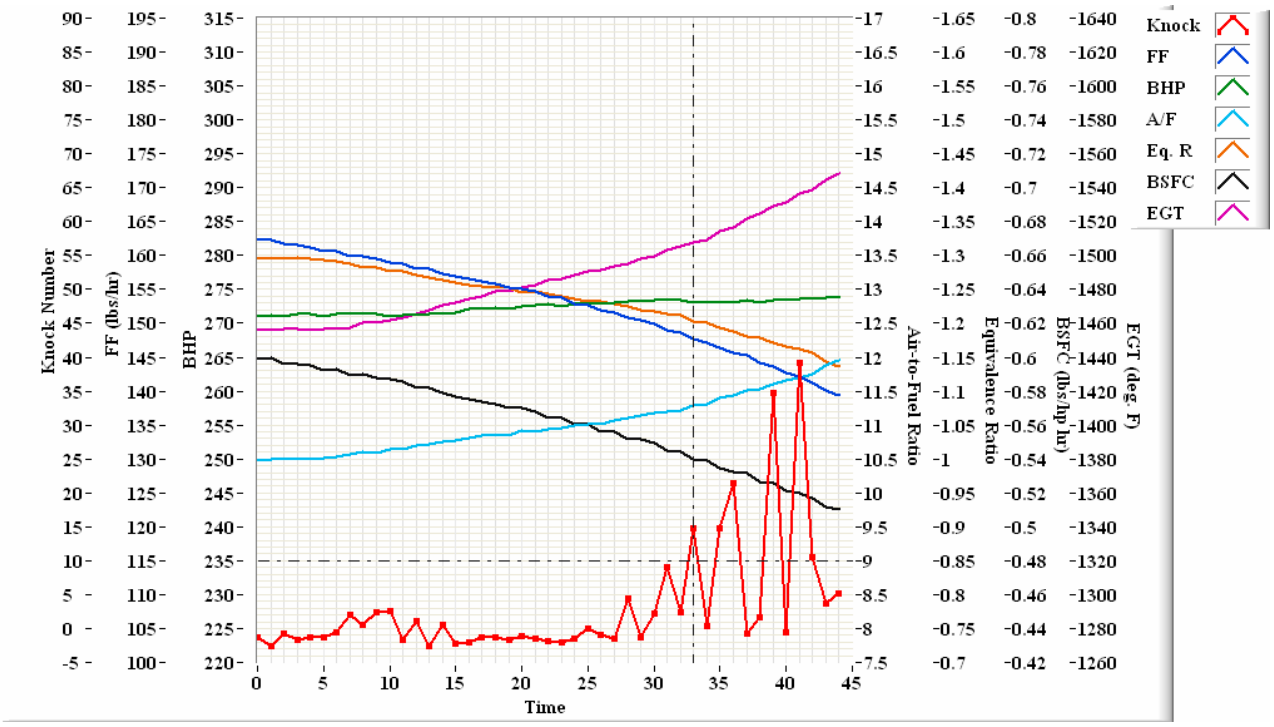


Figure B-169. Blend 44, 2700 rpm

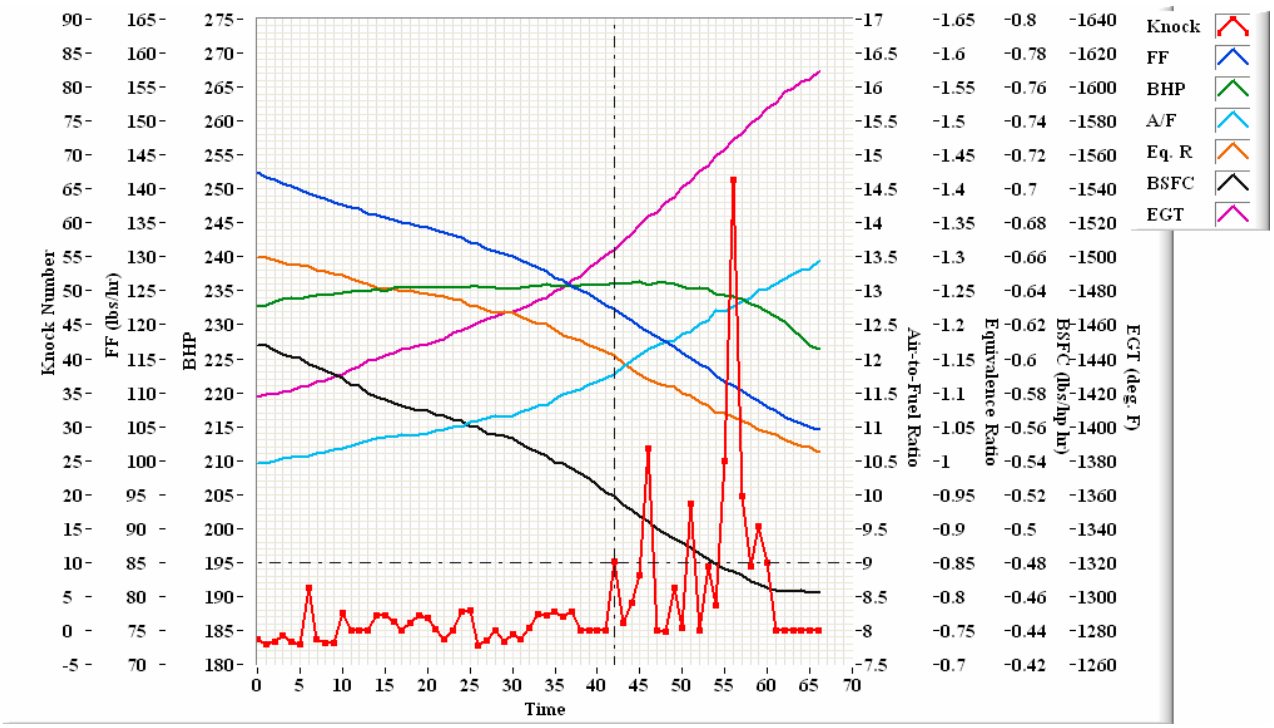


Figure B-170. Blend 44, 2600 rpm

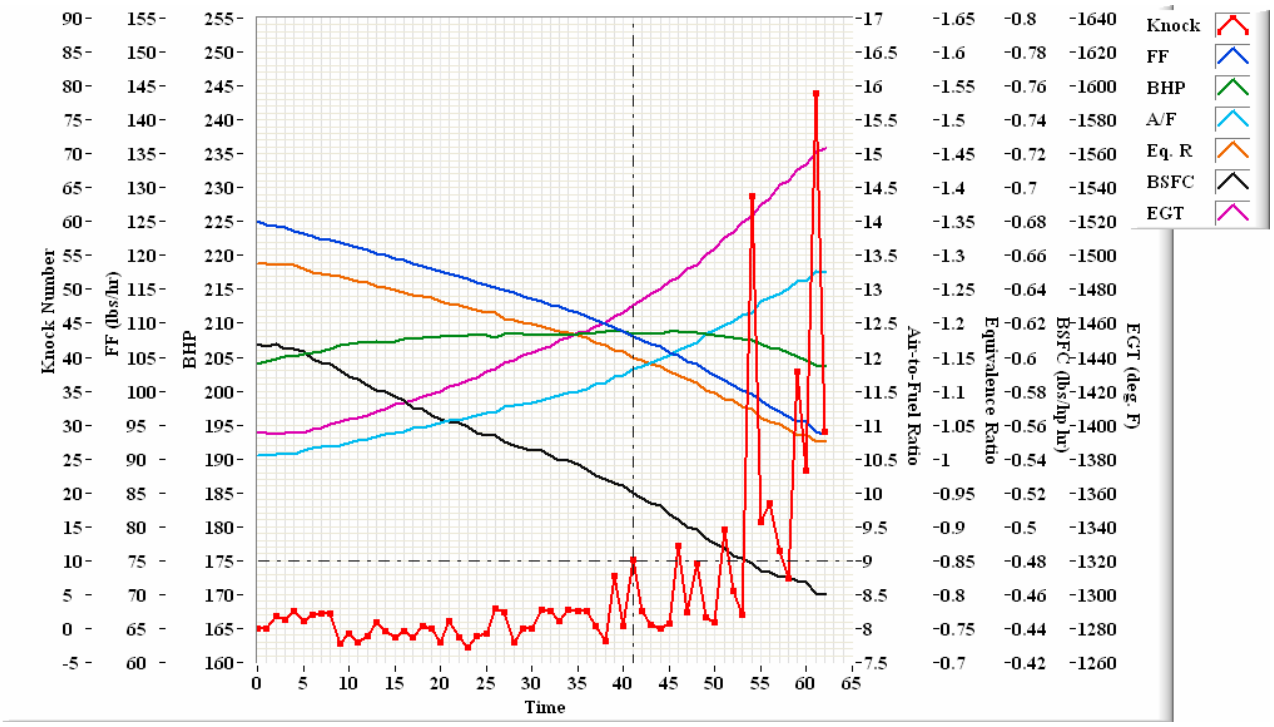


Figure B-171. Blend 44, 2450 rpm

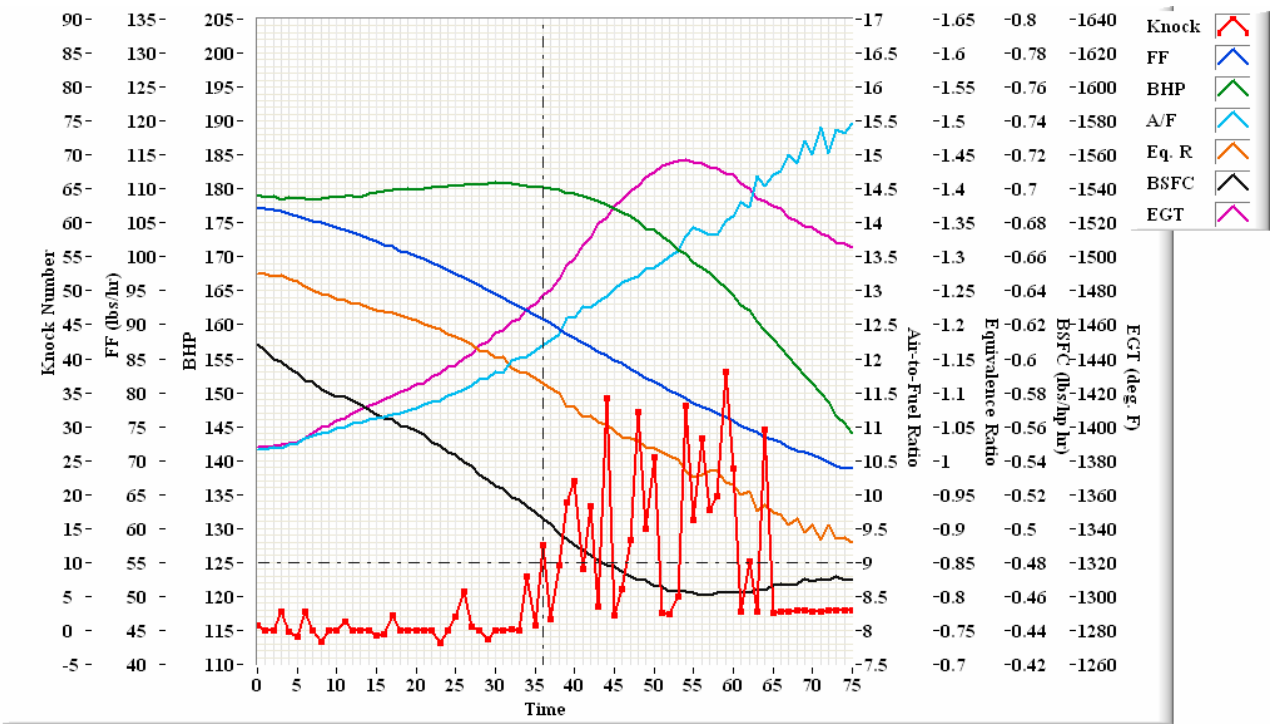


Figure B-172. Blend 44, 2350 rpm

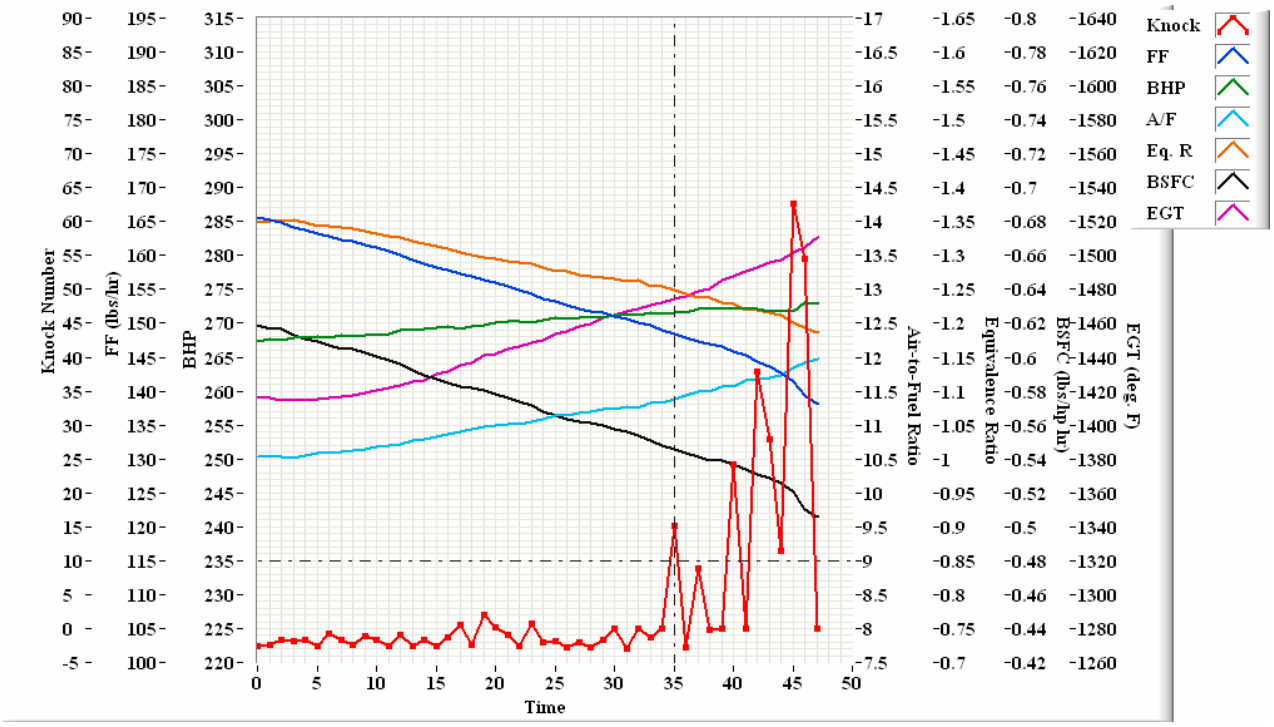


Figure B-173. Blend 45, 2700 rpm

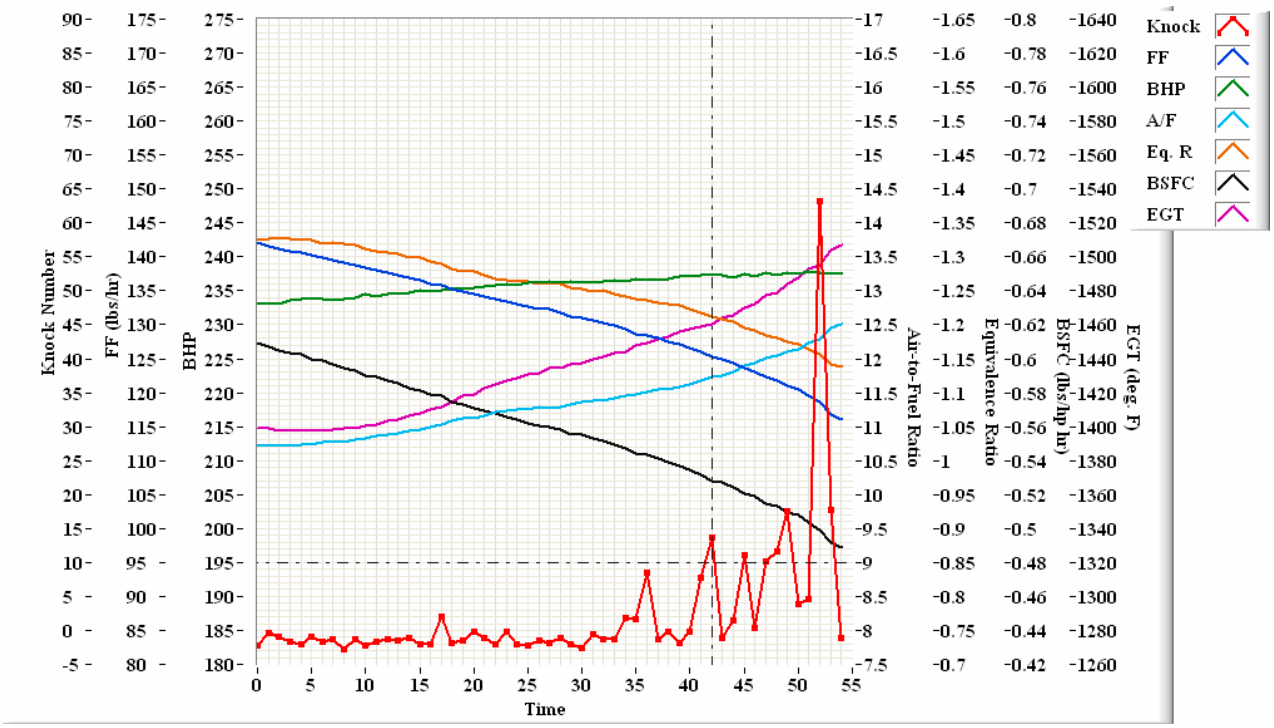


Figure B-174. Blend 45, 2600 rpm

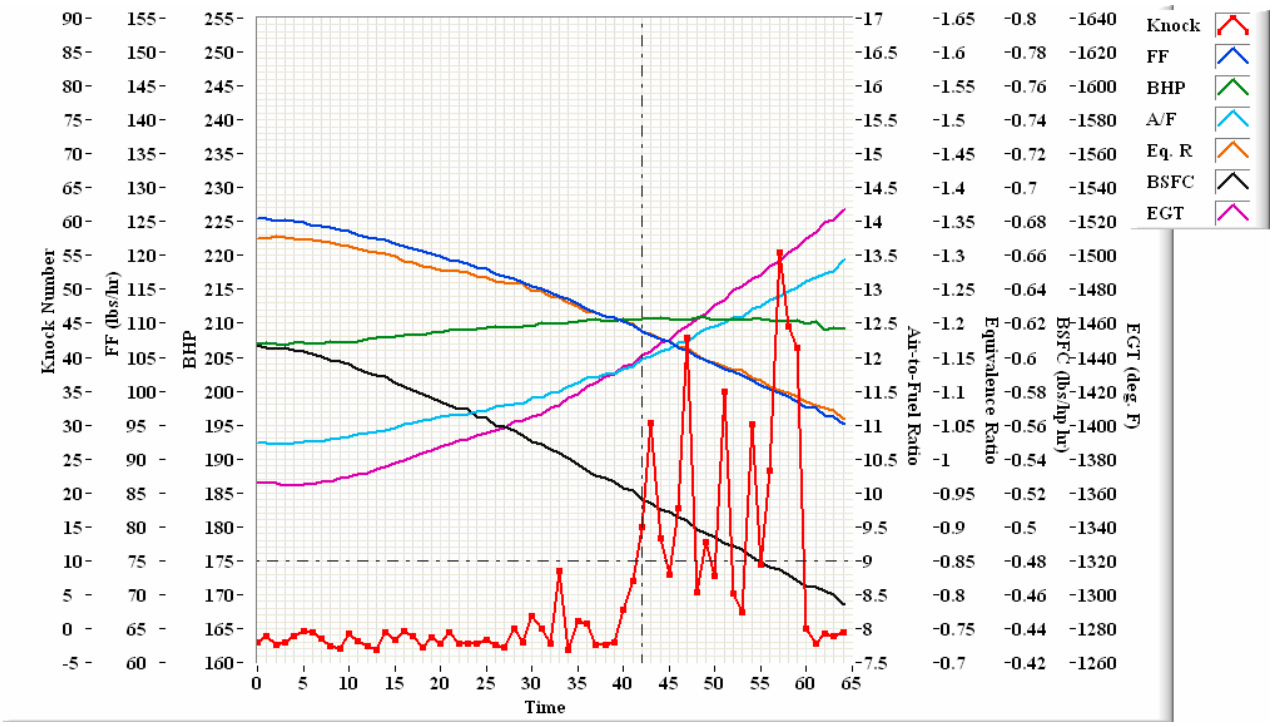


Figure B-175. Blend 45, 2450 rpm

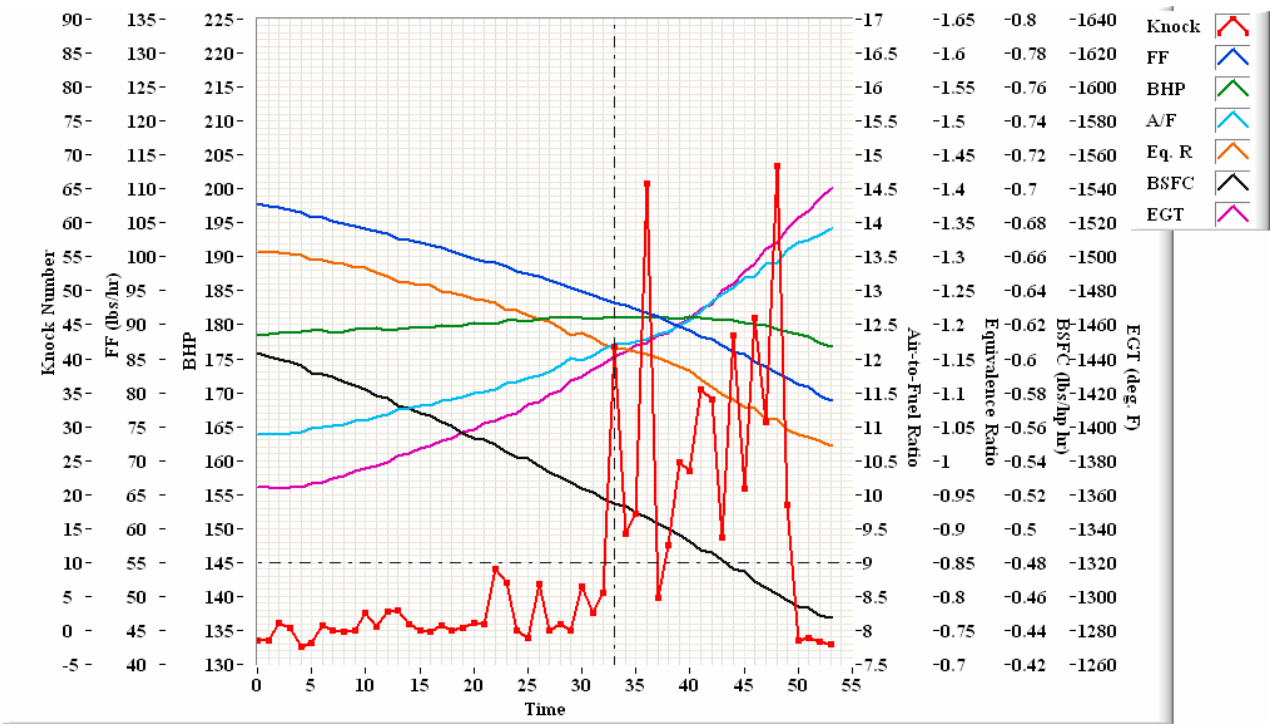


Figure B-176. Blend 45, 2350 rpm

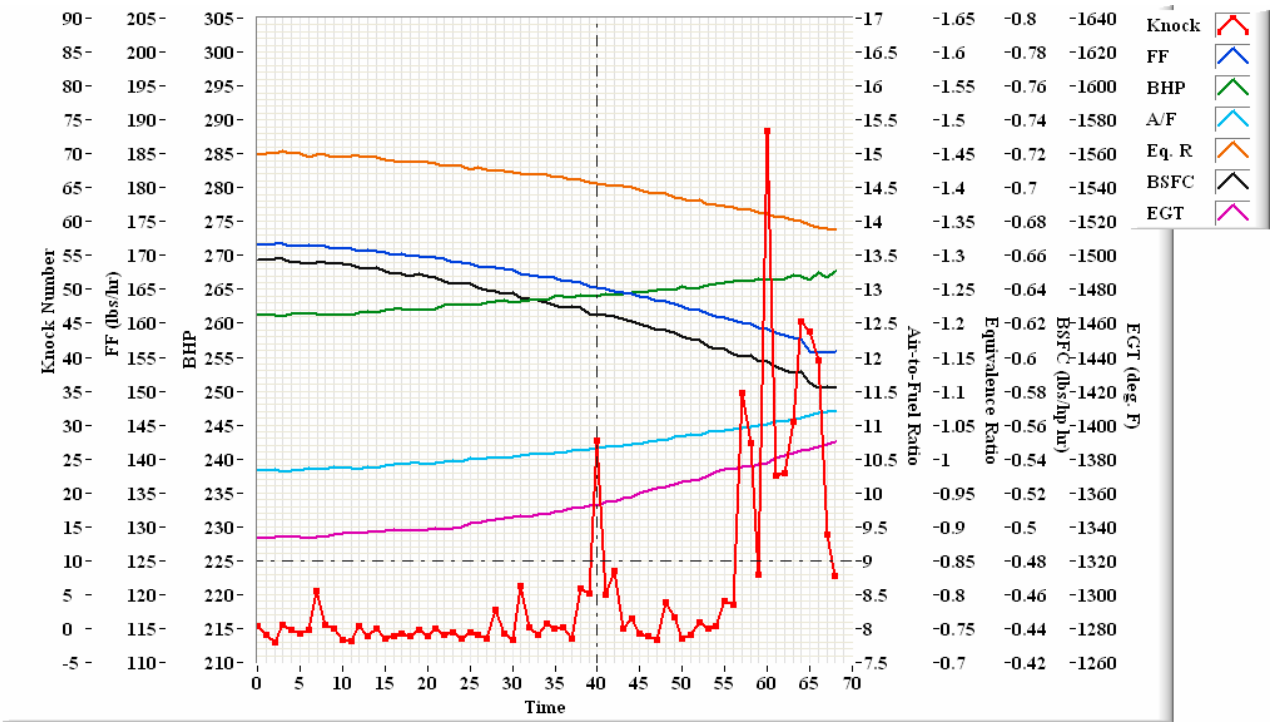


Figure B-177. Blend 46, 2700 rpm

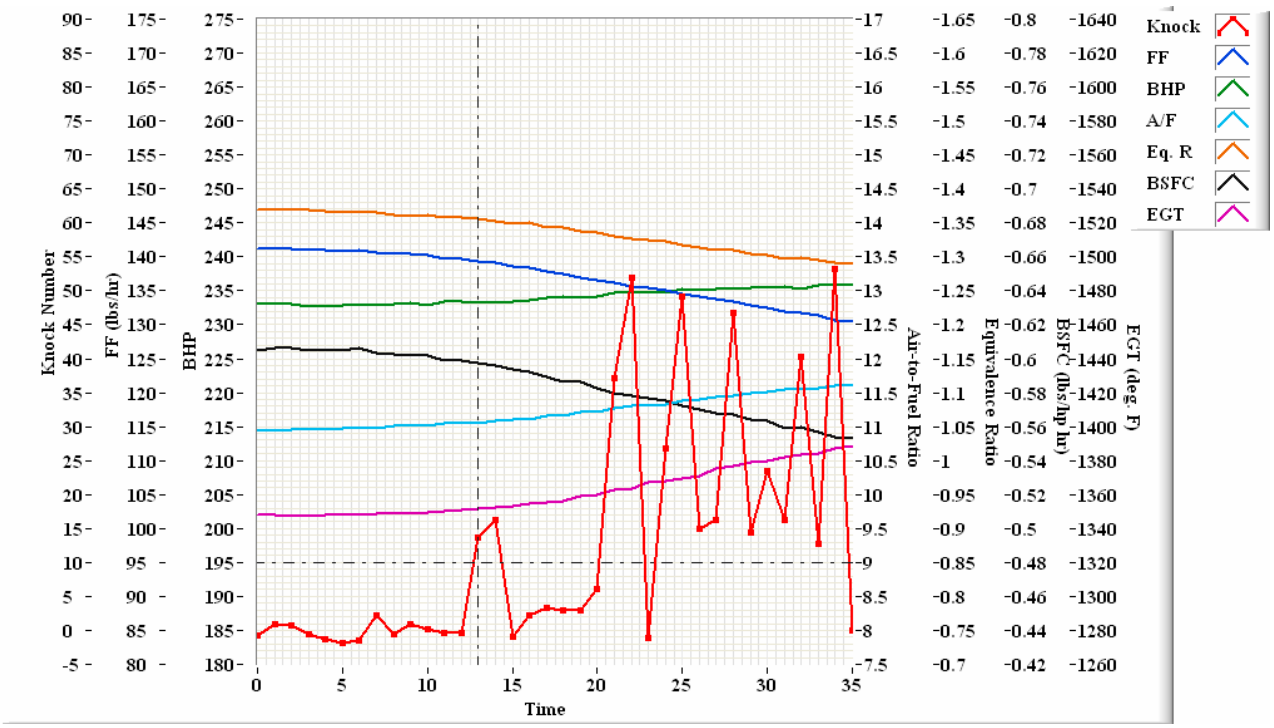


Figure B-178. Blend 46, 2600 rpm

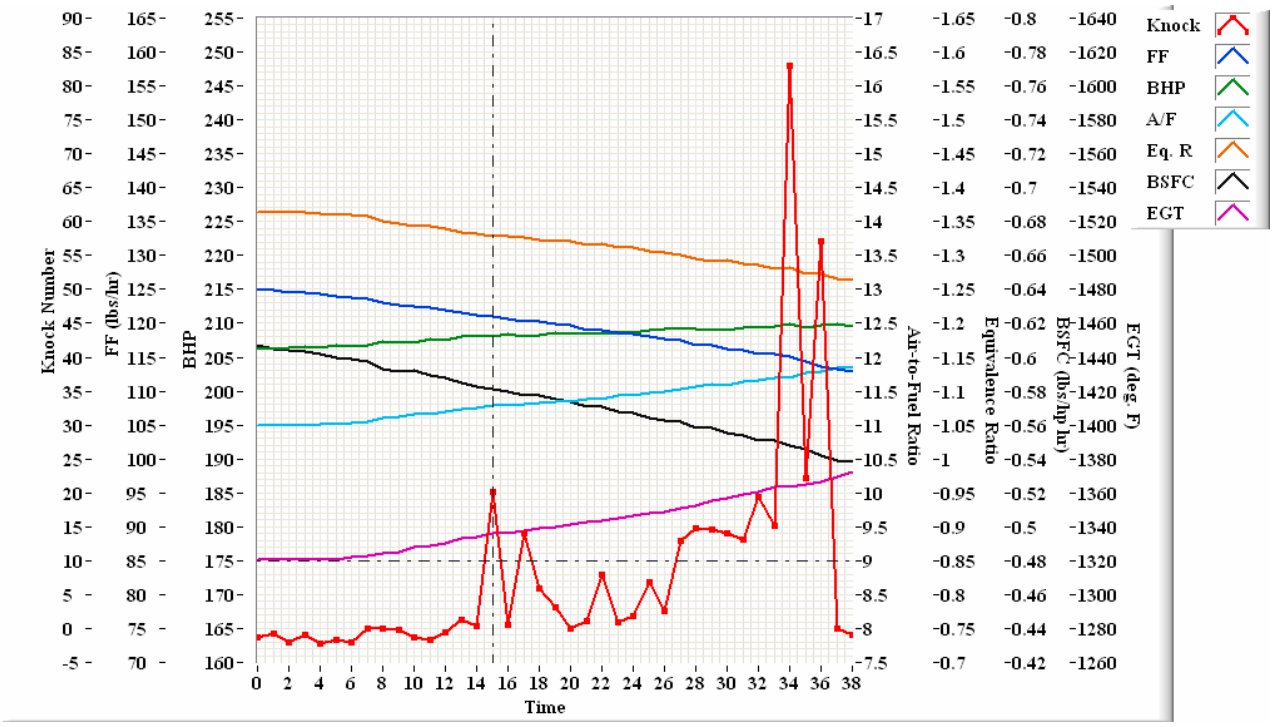


Figure B-179. Blend 46, 2450 rpm

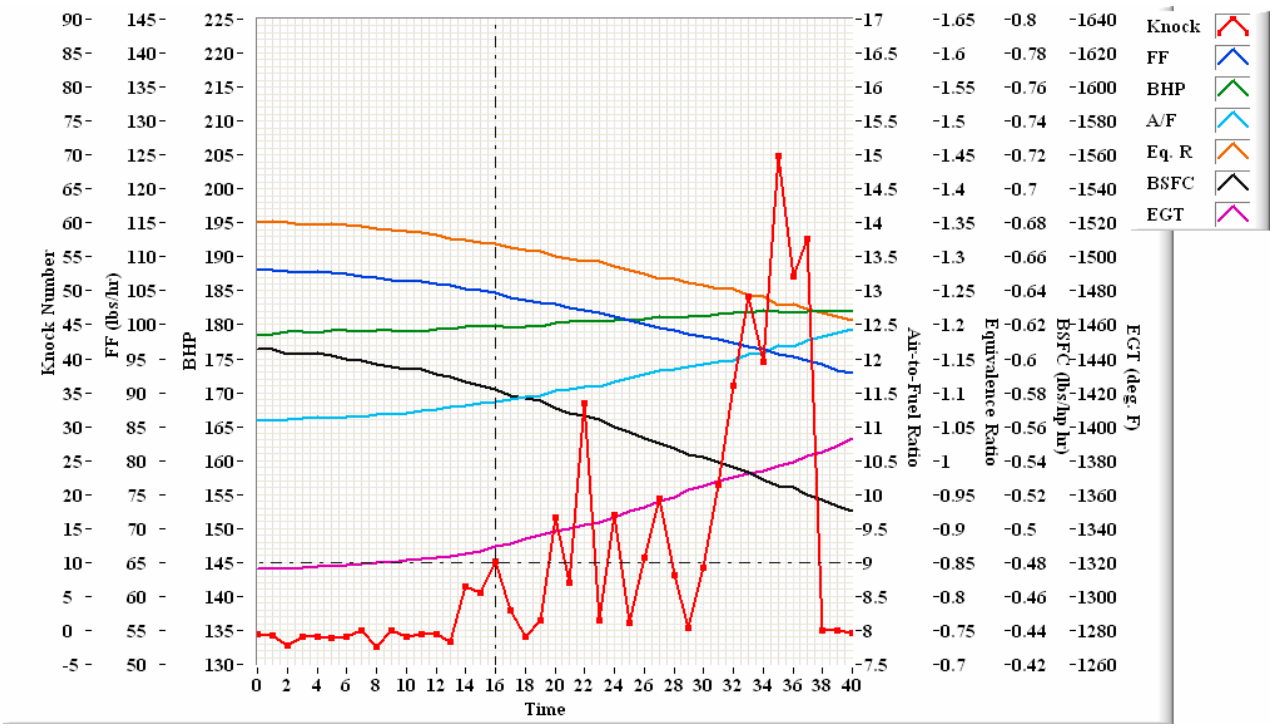


Figure B-180. Blend 46, 2350 rpm

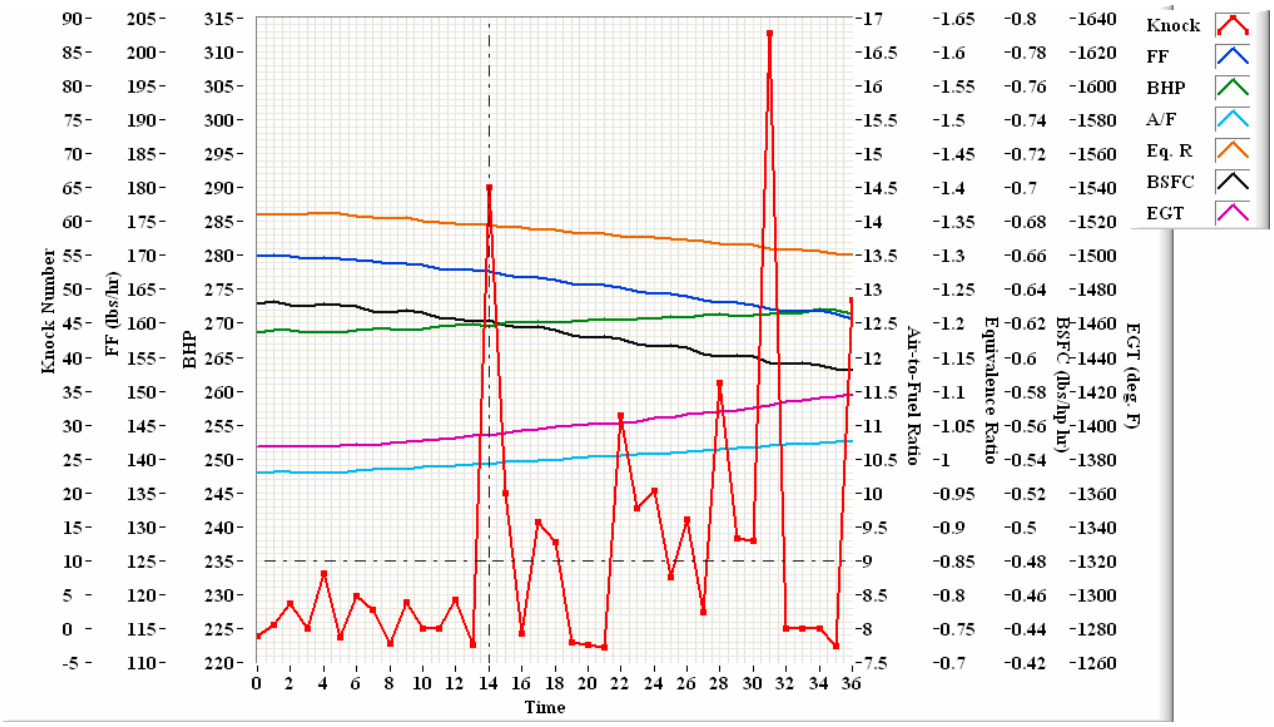


Figure B-181. Blend 47, 2700 rpm

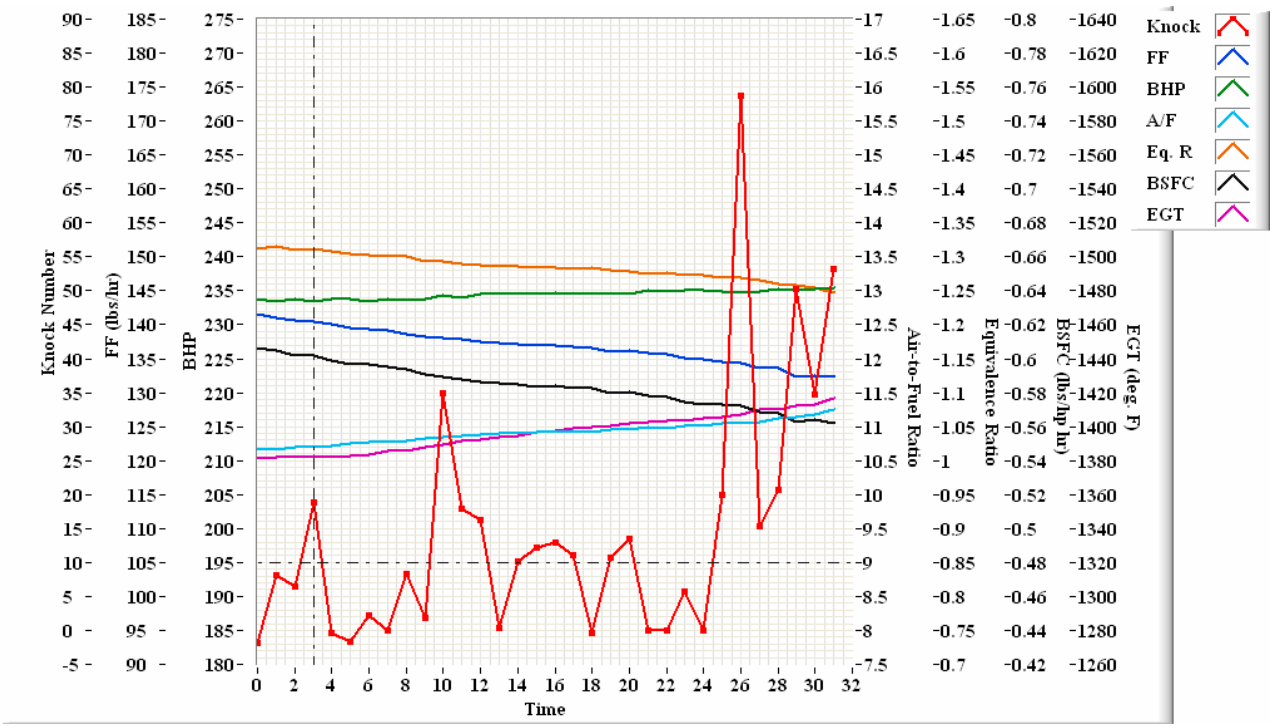


Figure B-182. Blend 47, 2600 rpm

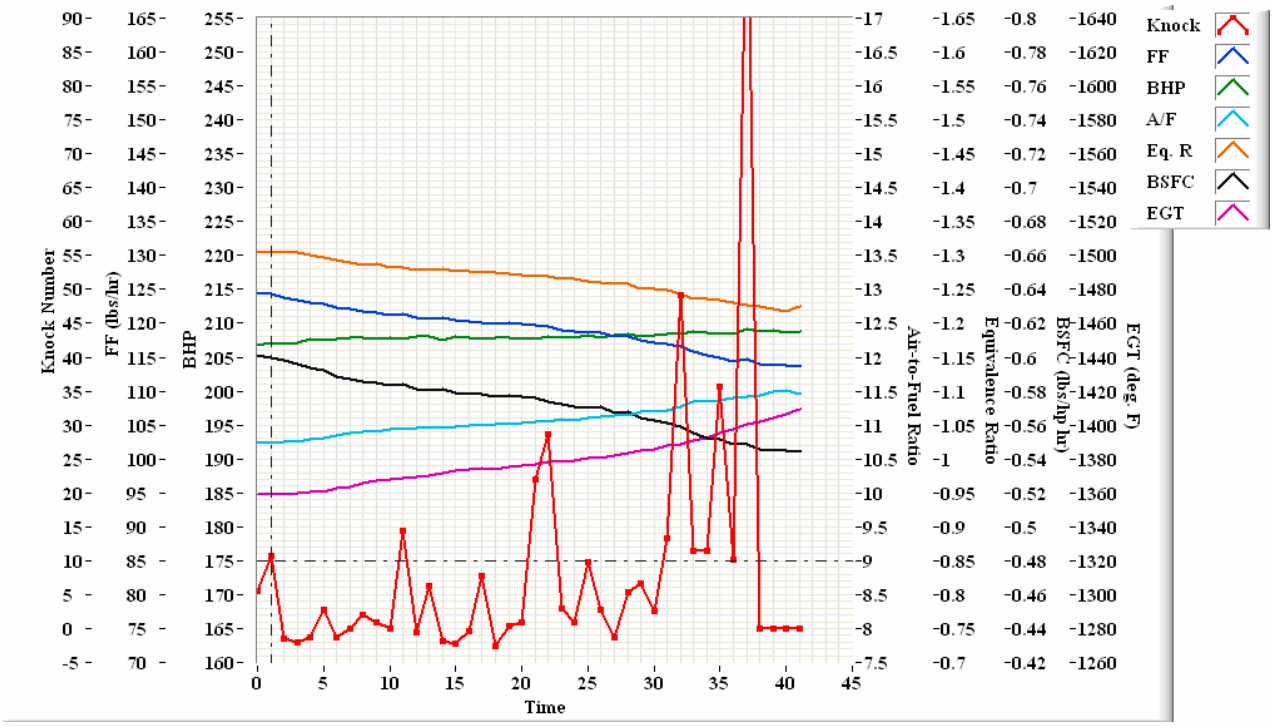


Figure B-183. Blend 47, 2450 rpm

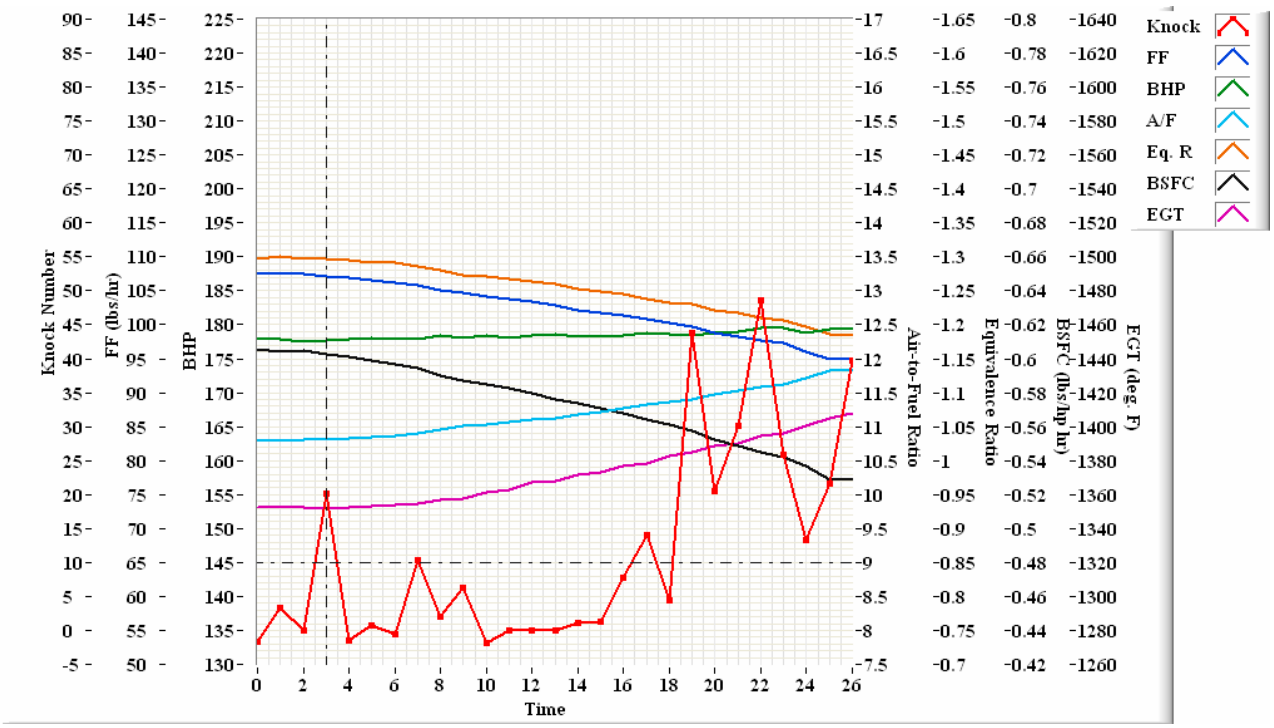


Figure B-184. Blend 47, 2350 rpm

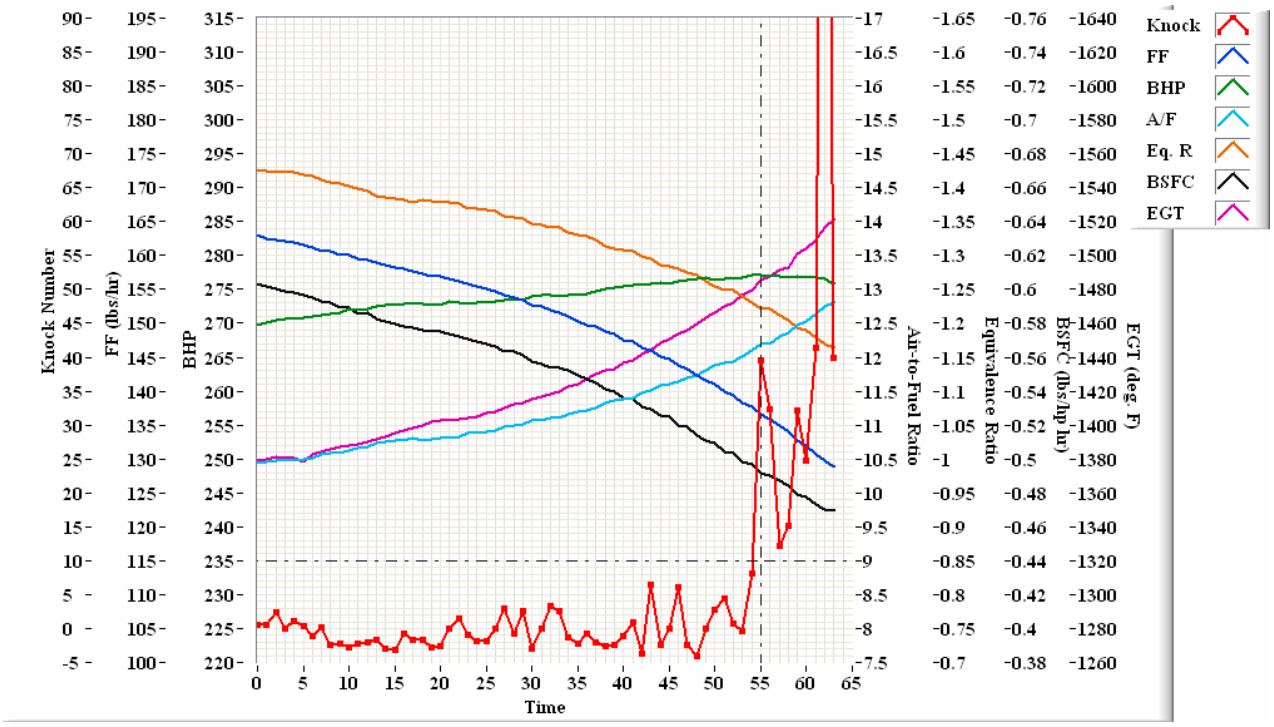


Figure B-185. Minimum Specification 100LL, 2700 rpm

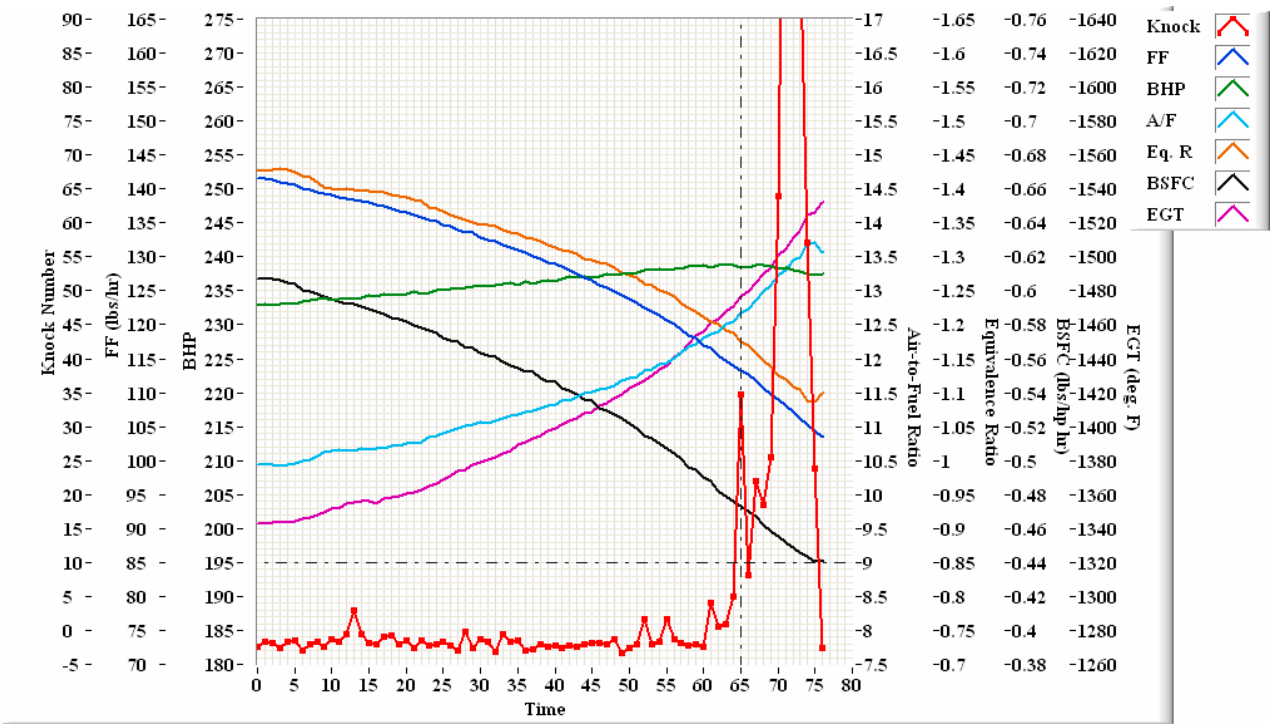


Figure B-186. Minimum Specification 100LL, 2600 rpm

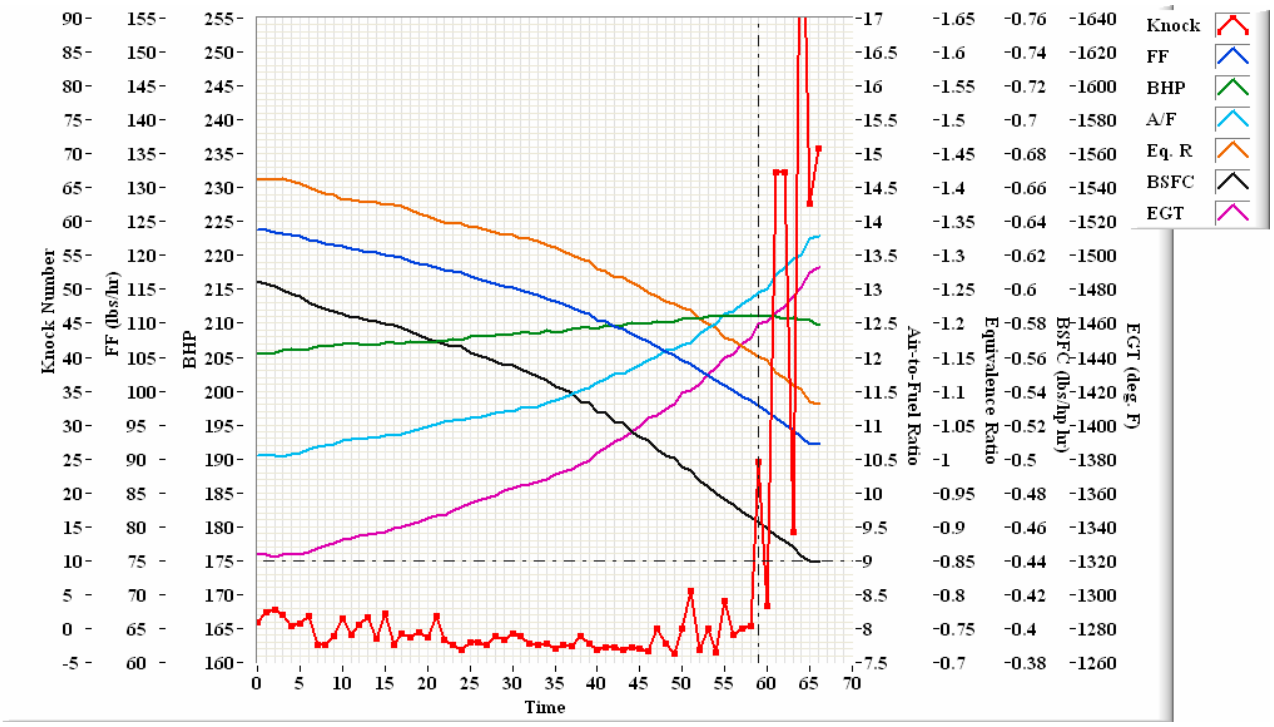


Figure B-187. Minimum Specification 100LL, 2450 rpm

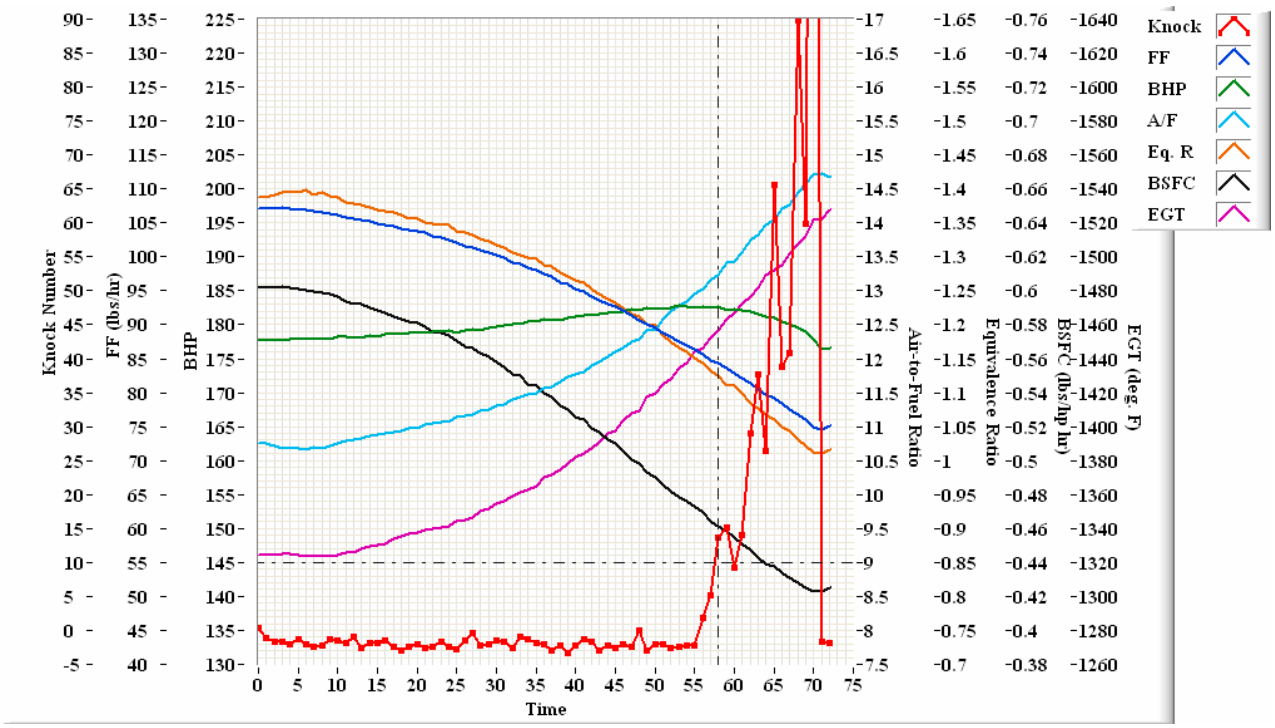


Figure B-188. Minimum Specification 100LL, 2350 rpm

B.2 DETONATION-ONSET DATA.

Table B-1. Detonation-Onset Engine Parameters, Part 1

Blend	Fuel Flow (lb/hr)	Brake Horsepower	Air-to-Fuel Ratio (average)	Equivalence Ratio	Brake-Specific Fuel Consumption (lb/hp hr)	Manifold Absolute Pressure (inHg)	Brake Mean Effective Pressure (psi)
1	154.9	265.2	10.64	1.304	0.585	29.03	143.7
1	153.5	265.3	10.77	1.288	0.578	29.03	143.8
1	155.6	264.1	10.59	1.310	0.589	29.03	143.1
1	137.7	233.7	10.63	1.305	0.589	27.45	131.5
1	135.3	234.6	10.80	1.285	0.576	27.45	132.0
1	134.3	234.7	10.84	1.280	0.573	27.45	132.1
1	119.9	206.8	10.78	1.287	0.580	26.18	123.5
1	120.5	207.2	10.73	1.293	0.582	26.19	123.8
1	119.1	207.1	10.83	1.281	0.575	26.21	123.7
1	102.0	180.1	11.08	1.252	0.566	24.35	112.1
1	98.5	180.9	11.41	1.216	0.544	24.40	112.6
1	101.7	180.3	11.05	1.256	0.563	24.39	112.3
2	104.6	234.9	13.64	1.048	0.445	27.61	132.2
2	110.7	237.2	12.96	1.104	0.467	27.60	133.5
2	85.7	196.9	14.59	0.980	0.435	26.40	117.5

Table B-1. Detonation-Onset Engine Parameters, Part 1 (Continued)

Blend	Fuel Flow (lb/hr)	Brake Horsepower	Air-to-Fuel Ratio (average)	Equivalence Ratio	Brake-Specific Fuel Consumption (lb/hp hr)	Manifold Absolute Pressure (inHg)	Brake Mean Effective Pressure (psi)
2	76.9	174.0	14.25	1.004	0.442	24.63	108.3
3	94.0	202.5	13.10	1.028	0.464	26.10	120.9
3	102.2	222.6	13.43	1.003	0.459	27.33	125.2
3	84.5	177.5	12.91	1.043	0.476	24.28	110.4
3	86.7	177.8	12.59	1.069	0.487	24.11	110.7
3	79.9	170.6	13.44	1.001	0.468	24.28	106.2
3	83.6	176.5	12.96	1.039	0.474	24.28	109.9

Table B-2. Detonation-Onset Engine Parameters, Part 2

Blend	Engine Speed (rpm)	Engine Torque (ft-lb)	Fuel Flow (gal/hr)	Engine Inlet Air Temperature (°F)	Engine Inlet Air Pressure (inHg)	Test Cell Barometer (inHg)	Engine Cowling Temperature (°F)
1	2699	516	24.7	104	29.54	29.55	103
1	2699	517	24.5	104	29.54	29.55	104
1	2699	514	24.9	105	29.54	29.55	105
1	2599	473	22.2	104	29.52	29.55	104
1	2599	474	21.7	104	29.53	29.55	105
1	2599	474	21.5	104	29.53	29.55	104
1	2449	443	19.2	104	29.52	29.55	106
1	2449	444	19.3	104	29.53	29.55	104
1	2450	445	19.2	104	29.54	29.55	104
1	2350	402	16.3	104	29.52	29.55	106
1	2350	404	15.8	104	29.56	29.55	106
1	2350	403	16.4	104	29.54	29.55	105
2	2599	476	16.3	102	29.57	29.56	104
2	2599	479	17.0	103	29.57	29.56	105
2	2450	422	13.2	104	29.55	29.55	104
2	2350	389	11.8	103	29.54	29.55	106
3	2450	434	14.1	104	29.58	29.57	105
3	2600	454	15.5	105	29.56	29.56	105
3	2350	397	12.7	104	29.56	29.57	107
3	2350	397	13.0	104	29.56	29.57	106
3	2350	381	12.0	103	29.56	29.57	106
3	2350	394	12.6	103	29.57	29.57	104

Table B-3. Detonation-Onset Engine Parameters, Part 3

Blend	Fuel Temperature (°F)	Fuel Density (lb/gal)	Metered Fuel Pressure (psi)	Unmetered Fuel Pressure (psi)	CHT 1 (°F)	CHT 2 (°F)	CHT 3 (°F)
1	59	6.24	8.3	25.4	477	444	477
1	60	6.24	8.1	25.4	475	445	477
1	60	6.25	8.3	25.4	476	444	477
1	59	6.25	6.6	25.4	476	453	477
1	59	6.27	6.2	25.4	476	453	478
1	59	6.25	6.2	25.4	477	455	477
1	59	6.25	5.0	25.3	474	457	475
1	59	6.25	5.1	25.3	474	457	475
1	59	6.25	5.0	25.3	473	457	475
1	59	6.25	3.6	25.3	471	454	470
1	59	6.25	3.4	25.3	471	453	470
1	59	6.25	3.7	25.3	471	454	470
2	59	6.49	3.9	25.8	474	454	474
2	59	6.49	4.3	25.8	473	455	469
2	59	6.49	2.6	25.7	475	463	471
2	59	6.49	2.2	25.6	470	455	466
3	59	6.66	3.0	25.8	469	453	466
3	60	6.66	3.6	25.9	474	457	469
3	59	6.66	2.5	25.8	465	451	464
3	59	6.66	2.6	25.8	464	448	461
3	59	6.66	2.2	25.8	465	449	460
3	59	6.66	2.4	25.8	463	449	459

CHT = Cylinder head temperature

Table B-4. Detonation-Onset Engine Parameters, Part 4

Blend	CHT 4 (°F)	CHT 5 (°F)	CHT 6 (°F)	EGT 1 (°F)	EGT 2 (°F)	EGT 3 (°F)	EGT 4 (°F)
1	459	466	474	1437	1377	1478	1415
1	461	466	473	1442	1392	1485	1422
1	459	467	475	1433	1381	1475	1411
1	463	471	475	1391	1356	1444	1382
1	461	470	475	1404	1368	1456	1393
1	464	471	476	1407	1369	1460	1396
1	466	474	476	1363	1336	1412	1367
1	466	475	477	1364	1335	1413	1369
1	464	471	476	1361	1336	1415	1368
1	464	470	477	1372	1345	1423	1376
1	464	469	477	1393	1363	1441	1397
1	463	469	477	1371	1343	1419	1370
2	464	471	477	1566	1509	1610	1546
2	465	471	475	1536	1484	1580	1516
2	469	476	478	1554	1534	1587	1572
2	466	470	479	1535	1514	1570	1542
3	465	469	475	1554	1515	1595	1556
3	470	471	477	1609	1564	1638	1601
3	464	466	475	1529	1496	1564	1526
3	462	464	475	1509	1471	1543	1508
3	463	466	476	1545	1530	1576	1557
3	462	465	474	1534	1503	1574	1532

CHT = Cylinder head temperature
EGT = Exhaust gas temperature

Table B-5. Detonation-Onset Engine Parameters, Part 5

Blend	EGT 5 (°F)	EGT 6 (°F)	Oil Inlet Temperature (°F)	Oil Pressure (psi)	Engine Inlet Air Humidity Ratio (Gr/lb)	Engine Inlet Air Relative Humidity (%)	Engine Intake Airflow (lb/hr)
1	1448	1415	229	65	0.5	0	1686
1	1454	1425	230	66	0.4	0	1677
1	1443	1410	244	65	0.5	0	1679
1	1412	1394	230	64	0.5	0	1445
1	1428	1403	244	64	0.4	0	1435
1	1427	1408	229	64	0.4	0	1441
1	1386	1387	231	62	0.4	0	1269
1	1389	1388	241	62	0.5	0	1274
1	1393	1386	230	62	0.5	0	1279
1	1393	1397	236	60	0.5	0	1116
1	1418	1417	238	60	0.5	0	1117
1	1392	1394	243	60	0.4	0	1110
2	1587	1556	247	62	0.5	0	1459
2	1553	1527	235	62	0.5	0	1442
2	1578	1581	245	61	0.5	0	1277
2	1557	1557	247	59	0.5	0	1122
3	1574	1561	243	61	0.4	0	1261
3	1633	1606	245	62	0.4	0	1421
3	1541	1531	238	60	0.4	0	1112
3	1522	1506	235	59	0.4	0	1093
3	1565	1559	246	59	0.4	0	1102
3	1547	1535	232	60	0.4	0	1110

EGT = Exhaust gas temperature
Gr = Grains of moisture per pound of dry air

Table B-6. Detonation-Onset Engine Parameters, Part 6

Blend	Fuel Flow (lb/hr)	Brake Horsepower	Air-to-Fuel Ratio (average)	Equivalence Ratio	Brake-Specific Fuel Consumption (lb/hp hr)	Manifold Absolute Pressure (inHg)	Brake Mean Effective Pressure (psi)
4	119.5	265.1	13.54	1.066	0.451	29.06	143.6
4	126.6	267.5	12.89	1.120	0.473	29.07	144.9
4	106.5	236.3	13.47	1.071	0.451	27.61	132.9
4	103.1	235.1	13.75	1.049	0.439	27.60	132.3
4	107.6	237.1	13.37	1.079	0.454	27.60	133.4
4	109.1	237.4	13.20	1.093	0.460	27.60	133.6
4	97.0	210.3	13.12	1.100	0.461	26.34	125.5
4	96.9	209.9	13.12	1.100	0.462	26.33	125.3
4	94.6	209.7	13.43	1.074	0.451	26.34	125.2
4	79.4	178.5	13.90	1.040	0.445	24.53	112.1
4	78.4	177.4	14.16	1.019	0.442	24.52	110.4
4	80.2	179.4	13.83	1.044	0.447	24.52	111.6
4	117.8	265.0	13.50	1.069	0.445	29.06	143.6
4	121.0	264.6	13.38	1.078	0.457	29.06	143.3
4	98.3	210.0	13.01	1.110	0.468	26.33	125.4
4	82.9	181.1	13.48	1.070	0.458	24.49	112.7
5	113.2	235.5	12.83	1.102	0.480	27.64	132.5
5	111.4	235.8	13.00	1.088	0.473	27.65	132.7
5	111.6	235.5	12.92	1.094	0.474	27.65	132.5
5	95.5	207.9	13.40	1.060	0.459	26.49	124.5
5	98.4	209.6	13.08	1.081	0.469	26.49	125.2
5	96.3	208.6	13.30	1.060	0.462	26.50	124.4
5	95.7	208.2	13.35	1.060	0.460	26.50	124.3
5	86.0	180.6	13.10	1.080	0.476	24.62	112.4
5	84.4	179.7	13.35	1.060	0.470	24.58	111.9
5	84.0	179.7	13.34	1.060	0.467	24.62	111.9
5	83.1	179.0	13.50	1.047	0.464	24.62	111.4
5	94.5	207.9	13.54	1.045	0.454	26.53	124.1

Table B-7. Detonation-Onset Engine Parameters, Part 7

Blend	Engine Speed (rpm)	Engine Torque (ft-lb)	Fuel Flow (gal/hr)	Engine Inlet Air Temperature (°F)	Engine Inlet Air Pressure (inHg)	Test Cell Barometer (inHg)	Engine Cowling Temperature (°F)
4	2699	516	18.8	104	29.56	29.55	104
4	2700	520	19.9	105	29.56	29.55	106
4	2600	477	16.8	105	29.55	29.55	106
4	2600	475	16.2	105	29.55	29.55	106
4	2600	479	16.9	105	29.55	29.55	107
4	2600	480	17.2	105	29.55	29.56	106
4	2450	451	15.3	105	29.55	29.56	107
4	2450	450	15.4	105	29.55	29.56	108
4	2450	450	14.9	104	29.56	29.56	105
4	2350	403	12.8	104	29.56	29.57	107
4	2350	396	12.3	103	29.56	29.57	106
4	2350	401	12.6	103	29.56	29.57	106
4	2700	516	18.8	104	29.56	29.55	105
4	2700	515	19.0	105	29.55	29.55	106
4	2450	450	15.5	104	29.55	29.56	107
4	2350	405	13.0	104	29.54	29.57	105
5	2599	476	17.7	105	29.8	29.81	114
5	2599	476	17.4	105	29.8	29.82	112
5	2599	476	17.5	105	29.79	29.82	114
5	2450	447	15.0	104	29.81	29.82	114
5	2450	449	15.4	104	29.81	29.82	112
5	2449	447	15.1	104	29.81	29.82	114
5	2450	446	15.0	104	29.82	29.82	114
5	2350	404	13.5	104	29.83	29.82	114
5	2350	402	13.3	104	29.8	29.82	112
5	2350	402	13.1	104	29.83	29.82	114
5	2350	401	13.1	103	29.81	29.82	113
5	2450	446	14.8	105	29.82	29.82	113

Table B-8. Detonation-Onset Engine Parameters, Part 8

Blend	Fuel Temperature (°F)	Fuel Density (lb/gal)	Metered Fuel Pressure (psi)	Unmetered Fuel Pressure (psi)	CHT 1 (°F)	CHT 2 (°F)	CHT 3 (°F)
4	62	6.35	4.9	25.7	476	445	477
4	62	6.35	5.5	25.8	476	444	474
4	62	6.35	4.0	25.8	476	451	467
4	62	6.36	3.7	25.8	475	450	466
4	62	6.35	4.0	25.8	476	450	467
4	62	6.35	4.2	25.8	475	449	468
4	62	6.35	3.3	25.7	476	452	469
4	62	6.36	3.4	25.7	475	449	468
4	61	6.36	3.2	25.7	473	451	467
4	61	6.36	2.3	25.7	469	446	465
4	61	6.36	2.2	25.7	468	446	464
4	61	6.36	2.3	25.7	467	444	462
4	62	6.35	5.0	25.8	476	444	477
4	62	6.35	5.0	25.8	477	446	474
4	61	6.36	3.4	25.7	474	448	467
4	61	6.36	2.5	25.7	469	446	465
5	63	6.39	4.4	25.7	475	445	466
5	63	6.39	4.3	25.7	476	447	466
5	63	6.39	4.3	25.7	476	448	464
5	62	6.39	3.2	25.7	474	446	465
5	62	6.39	3.3	25.6	474	447	463
5	62	6.42	3.3	25.7	476	450	466
5	62	6.39	3.1	25.6	475	449	465
5	62	6.39	2.6	25.6	472	445	465
5	62	6.39	2.5	25.6	469	443	460
5	62	6.39	2.5	25.6	471	445	461
5	62	6.39	2.4	25.6	471	444	461
5	62	6.39	3.1	25.7	475	448	466

CHT = Cylinder head temperature

Table B-9. Detonation-Onset Engine Parameters, Part 9

Blend	CHT 4 (°F)	CHT 5 (°F)	CHT 6 (°F)	EGT 1 (°F)	EGT 2 (°F)	EGT 3 (°F)	EGT 4 (°F)
4	461	469	475	1590	1536	1631	1570
4	459	468	476	1548	1492	1589	1524
4	466	467	475	1549	1498	1594	1534
4	462	467	472	1571	1518	1613	1552
4	461	467	476	1539	1491	1584	1521
4	461	469	473	1529	1480	1570	1513
4	465	471	476	1484	1444	1527	1487
4	464	470	475	1474	1437	1521	1479
4	461	466	475	1499	1465	1545	1506
4	459	467	474	1497	1474	1541	1501
4	459	466	475	1522	1497	1558	1521
4	457	464	474	1510	1485	1546	1512
4	462	469	476	1579	1521	1621	1556
4	465	470	478	1581	1530	1629	1559
4	463	467	476	1476	1441	1522	1480
4	458	466	475	1476	1450	1520	1480
5	459	465	472	1524	1479	1576	1513
5	461	467	475	1529	1488	1580	1522
5	462	466	475	1529	1484	1581	1522
5	459	467	475	1509	1473	1557	1509
5	460	465	475	1498	1461	1542	1498
5	463	466	476	1506	1472	1553	1511
5	462	467	475	1513	1477	1561	1513
5	458	468	474	1483	1449	1525	1484
5	455	463	474	1491	1457	1533	1491
5	458	464	475	1498	1459	1540	1500
5	458	464	474	1501	1461	1542	1498
5	460	466	473	1530	1490	1574	1530

CHT = Cylinder head temperature
EGT = Exhaust gas temperature

Table B-10. Detonation-Onset Engine Parameters, Part 10

Blend	EGT 5 (°F)	EGT 6 (°F)	Oil Inlet Temperature (°F)	Oil Pressure (psi)	Engine Inlet Air Humidity Ratio (Gr/lb)	Engine Inlet Air Relative Humidity (%)	Engine Intake Airflow (lb/hr)
4	1613	1578	235	64	0.3	0	1667
4	1561	1530	243	63	0.3	0	1674
4	1570	1545	233	62	0.3	0	1447
4	1594	1558	244	62	0.3	0	1446
4	1562	1527	223	62	0.3	0	1436
4	1553	1521	243	62	0.3	0	1443
4	1507	1493	240	60	0.3	0	1275
4	1497	1488	230	61	0.3	0	1281
4	1526	1517	234	60	0.3	0	1278
4	1518	1512	234	58	0.4	0	1121
4	1540	1528	235	60	0.4	0	1119
4	1526	1519	236	59	0.4	0	1125
4	1598	1562	240	62	0.3	0	1665
4	1601	1569	241	62	0.3	0	1669
4	1500	1488	244	60	0.3	0	1278
4	1500	1495	242	59	0.3	0	1122
5	1553	1512	246	64	0.4	0	1447
5	1559	1521	224	65	0.4	0	1450
5	1560	1524	244	64	0.4	0	1444
5	1534	1524	244	61	0.4	0	1285
5	1523	1509	240	62	0.4	0	1292
5	1536	1522	245	62	0.4	0	1289
5	1543	1524	242	62	0.4	0	1282
5	1504	1492	243	60	0.3	0	1120
5	1511	1501	238	60	0.3	0	1117
5	1520	1510	246	60	0.3	0	1126
5	1520	1511	239	61	0.3	0	1124
5	1554	1537	223	62	0.4	0	1287

EGT = Exhaust gas temperature
Gr = Grains of moisture per pound of dry air

Table B-11. Detonation-Onset Engine Parameters, Part 11

Blend	Fuel Flow (lb/hr)	Brake Horsepower	Air-to-Fuel Ratio (average)	Equivalence Ratio	Brake-Specific Fuel Consumption (lb/hp hr)	Manifold Absolute Pressure (inHg)	Brake Mean Effective Pressure (psi)
6	90.1	207.2	14.00	1.040	0.435	26.50	123.7
6	87.7	203.5	14.30	1.010	0.431	26.50	122.2
6	76.8	174.7	14.40	1.010	0.440	24.62	110.1
6	74.3	169.6	14.60	0.990	0.438	24.62	105.6
6	74.2	169.7	14.60	0.990	0.437	24.63	105.6
7	130.1	270.6	12.70	1.137	0.481	29.39	146.6
7	130.8	270.8	12.67	1.139	0.483	29.37	146.7
7	132.6	270.6	12.48	1.157	0.491	29.37	146.8
7	112.8	237.7	12.93	1.116	0.474	27.61	133.7
7	112.3	237.0	12.96	1.113	0.474	27.60	133.3
7	114.0	236.9	12.74	1.133	0.481	27.61	133.3
7	112.5	237.3	12.90	1.120	0.474	27.61	133.7
7	109.9	236.3	13.20	1.094	0.465	27.62	132.9
7	100.1	211.4	13.00	1.110	0.474	26.47	126.0
7	100.9	211.3	12.85	1.123	0.479	26.45	126.2
7	98.6	210.6	13.13	1.099	0.468	26.45	125.7
7	99.6	211.4	12.93	1.116	0.471	26.47	126.2
7	96.6	210.2	13.33	1.083	0.460	26.47	125.5
7	81.5	178.7	13.65	1.057	0.456	24.32	111.2
7	82.8	180.3	13.56	1.065	0.459	24.49	112.2
7	86.4	181.1	13.00	1.110	0.477	24.46	112.7
7	83.3	180.5	13.47	1.072	0.461	24.47	112.4
7	128.7	270.7	12.79	1.129	0.476	29.36	146.6

Table B-12. Detonation-Onset Engine Parameters, Part 12

Blend	Engine Speed (rpm)	Engine Torque (ft-lb)	Fuel Flow (gal/hr)	Engine Inlet Air Temperature (°F)	Engine Inlet Air Pressure (inHg)	Test Cell Barometer (inHg)	Engine Cowling Temperature (°F)
6	2450	444	14.2	103	29.86	29.85	114
6	2449	439	13.9	103	29.85	29.86	115
6	2350	395	12.2	102	29.86	29.86	115
6	2350	379	11.7	102	29.87	29.86	113
6	2350	379	11.7	102	29.86	29.86	113
7	2700	526	21.2	105	29.88	29.86	112
7	2700	526	21.5	105	29.86	29.86	113
7	2700	527	21.6	105	29.86	29.86	114
7	2600	480	18.4	105	29.85	29.86	113
7	2600	479	18.3	105	29.84	29.86	114
7	2600	479	18.6	106	29.86	29.86	115
7	2600	480	18.5	106	29.85	29.86	113
7	2600	477	17.9	106	29.85	29.86	113
7	2450	453	16.3	105	29.85	29.87	114
7	2450	453	16.4	105	29.85	29.87	113
7	2450	452	16.2	105	29.86	29.87	114
7	2450	453	16.2	105	29.86	29.86	115
7	2450	451	15.7	105	29.85	29.87	114
7	2350	399	13.3	102	29.87	29.86	114
7	2350	403	13.5	103	29.87	29.86	114
7	2350	405	14.2	103	29.87	29.86	115
7	2350	403	13.5	104	29.87	29.86	113
7	2700	526	21.0	106	29.85	29.86	114

Table B-13. Detonation-Onset Engine Parameters, Part 13

Blend	Fuel Temperature (°F)	Fuel Density (lb/gal)	Metered Fuel Pressure (psi)	Unmetered Fuel Pressure (psi)	CHT 1 (°F)	CHT 2 (°F)	CHT 3 (°F)
6	62	6.36	2.9	25.7	474	450	465
6	62	6.36	2.8	25.7	475	451	465
6	62	6.36	2.2	25.7	472	447	462
6	62	6.36	2.0	25.7	469	444	459
6	62	6.36	2.0	25.7	470	444	460
7	62	6.15	6.0	25.8	477	438	475
7	62	6.14	6.2	25.8	476	438	475
7	62	6.15	6.2	25.7	480	442	476
7	62	6.14	4.5	25.7	476	442	468
7	62	6.14	4.5	25.8	476	446	466
7	62	6.15	4.6	25.7	476	445	466
7	62	6.14	4.6	25.7	476	445	466
7	62	6.14	4.3	25.8	476	444	465
7	62	6.14	3.6	25.6	475	444	468
7	62	6.14	3.6	25.7	472	439	463
7	62	6.14	3.5	25.7	474	443	466
7	62	6.15	3.6	25.7	473	442	464
7	62	6.15	3.4	25.7	475	443	470
7	61	6.15	2.5	25.7	470	441	461
7	61	6.15	2.5	25.7	469	440	461
7	62	6.14	2.8	25.6	470	441	461
7	61	6.15	2.5	25.6	470	442	460
7	62	6.14	5.9	25.8	477	440	474

CHT = Cylinder head temperature

Table B-14. Detonation-Onset Engine Parameters, Part 14

Blend	CHT 4 (°F)	CHT 5 (°F)	CHT 6 (°F)	EGT 1 (°F)	EGT 2 (°F)	EGT 3 (°F)	EGT 4 (°F)
6	465	466	475	1541	1499	1579	1542
6	466	470	476	1551	1511	1589	1556
6	467	465	475	1535	1506	1566	1536
6	460	462	474	1539	1519	1564	1552
6	462	464	475	1538	1525	1561	1554
7	463	465	476	1537	1476	1576	1515
7	460	464	476	1525	1466	1563	1508
7	468	467	477	1525	1468	1568	1508
7	463	463	473	1499	1454	1551	1493
7	461	464	474	1505	1457	1557	1498
7	460	467	471	1489	1445	1539	1484
7	461	464	472	1497	1450	1548	1489
7	460	465	474	1521	1473	1571	1509
7	463	467	475	1464	1425	1510	1465
7	460	465	475	1459	1421	1504	1461
7	463	467	475	1468	1433	1516	1470
7	463	467	476	1466	1430	1512	1469
7	465	468	476	1488	1450	1531	1489
7	458	463	475	1488	1457	1526	1485
7	458	462	475	1484	1455	1527	1491
7	460	462	476	1448	1416	1489	1451
7	460	463	475	1480	1449	1522	1482
7	461	465	474	1539	1479	1580	1521

CHT = Cylinder head temperature
EGT = Exhaust gas temperature

Table B-15. Detonation-Onset Engine Parameters, Part 15

Blend	EGT 5 (°F)	EGT 6 (°F)	Oil Inlet Temperature (°F)	Oil Pressure (psi)	Engine Inlet Air Humidity Ratio (Gr/lb)	Engine Inlet Air Relative Humidity (%)	Engine Intake Airflow (lb/hr)
6	1562	1543	237	62	0.3	0	1278
6	1572	1558	234	61	0.3	0	1280
6	1551	1542	242	60	0.3	0	1125
6	1557	1551	224	59	0.3	0	1128
6	1558	1553	235	60	0.3	0	1120
7	1548	1518	239	64	0.3	0	1692
7	1540	1504	243	64	0.3	0	1701
7	1538	1502	242	63	0.3	0	1692
7	1531	1498	233	63	0.3	0	1440
7	1531	1500	245	62	0.3	0	1450
7	1516	1489	233	63	0.3	0	1441
7	1519	1491	239	63	0.3	0	1447
7	1547	1518	242	62	0.4	0	1447
7	1485	1469	246	60	0.4	0	1285
7	1478	1465	231	61	0.4	0	1290
7	1490	1477	228	61	0.3	0	1281
7	1485	1470	236	61	0.4	0	1279
7	1514	1494	231	60	0.4	0	1278
7	1505	1496	231	60	0.4	0	1107
7	1506	1493	241	60	0.4	0	1119
7	1468	1460	228	61	0.3	0	1124
7	1498	1485	241	60	0.4	0	1117
7	1557	1521	225	64	0.3	0	1688

EGT = Exhaust gas temperature
Gr = Grains of moisture per pound of dry air

Table B-16. Detonation-Onset Engine Parameters, Part 16

Blend	Fuel Flow (lb/hr)	Brake Horsepower	Air-to-Fuel Ratio (average)	Equivalence Ratio	Brake-Specific Fuel Consumption (lb/hp hr)	Manifold Absolute Pressure (inHg)	Brake Mean Effective Pressure (psi)
8	123.8	265.9	13.29	1.082	0.466	29.45	144.2
8	123.8	265.2	13.25	1.085	0.467	29.44	143.7
8	121.3	265.5	13.55	1.061	0.457	29.44	143.9
8	124.0	267.6	13.22	1.088	0.463	29.44	145.0
8	125.7	265.9	13.15	1.094	0.473	29.45	144.1
8	105.2	234.6	13.70	1.050	0.449	27.85	132.0
8	105.9	234.9	13.67	1.052	0.451	27.86	132.2
8	91.7	207.1	13.83	1.040	0.443	26.53	123.7
8	92.0	206.6	13.79	1.043	0.445	26.54	123.4
8	92.2	207.4	13.76	1.045	0.445	26.54	123.8
8	75.6	170.1	14.60	0.980	0.445	24.68	105.6
9	143.4	272.2	11.59	1.179	0.527	29.48	148.0
9	144.4	271.5	11.51	1.188	0.532	29.47	147.1
9	120.0	236.7	12.10	1.130	0.507	27.58	133.2
9	117.8	236.2	12.25	1.116	0.499	27.57	132.9
9	122.7	235.9	11.88	1.151	0.519	27.56	132.5
9	120.2	236.4	12.07	1.133	0.509	27.57	133.0
9	102.6	207.9	12.38	1.104	0.494	26.30	124.1
9	106.6	208.9	12.00	1.140	0.510	26.30	124.6
9	105.7	208.9	12.10	1.130	0.506	26.31	124.9
9	102.5	208.2	12.43	1.100	0.493	26.30	124.3
9	103.2	208.8	12.35	1.107	0.494	26.31	124.6
9	91.0	180.8	12.40	1.103	0.503	24.49	112.5
9	88.5	179.8	12.71	1.076	0.492	24.47	111.9
9	90.4	181.1	12.36	1.106	0.499	24.47	112.7
9	91.4	180.7	12.23	1.118	0.506	24.49	112.4
9	141.7	271.5	11.73	1.166	0.521	29.48	146.8
9	121.1	236.6	11.92	1.147	0.512	27.58	133.1

Table B-17. Detonation-Onset Engine Parameters, Part 17

Blend	Engine Speed (rpm)	Engine Torque (ft-lb)	Fuel Flow (gal/hr)	Engine Inlet Air Temperature (°F)	Engine Inlet Air Pressure (inHg)	Test Cell Barometer (inHg)	Engine Cowling Temperature (°F)
8	2698	518	20.1	106	29.96	29.95	110
8	2699	516	20.1	106	29.95	29.95	113
8	2698	516	19.4	106	29.95	29.95	113
8	2699	521	20.2	105	29.95	29.95	112
8	2699	517	20.5	104	29.96	29.95	114
8	2599	474	17.1	104	29.95	29.95	113
8	2599	475	17.2	104	29.95	29.95	115
8	2449	444	14.9	104	29.94	29.95	114
8	2449	443	15.0	104	29.94	29.95	115
8	2449	445	15.0	104	29.95	29.95	114
8	2350	380	12.3	104	29.96	29.95	114
9	2699	531	22.6	103	29.97	29.96	112
9	2699	528	22.7	104	29.97	29.96	115
9	2599	478	18.9	104	29.96	29.96	115
9	2599	477	18.6	104	29.96	29.96	114
9	2599	477	19.5	104	29.96	29.96	115
9	2599	478	19.0	104	29.96	29.96	115
9	2449	446	16.2	104	29.95	29.96	115
9	2449	447	16.9	104	29.95	29.96	115
9	2450	448	16.9	104	29.96	29.96	114
9	2450	446	16.2	104	29.95	29.96	115
9	2450	448	16.3	104	29.96	29.96	116
9	2350	404	14.4	103	29.96	29.96	115
9	2350	402	14.0	103	29.96	29.96	113
9	2350	405	14.3	103	29.96	29.96	115
9	2350	404	14.4	103	29.98	29.96	116
9	2699	527	22.5	104	29.98	29.96	114
9	2599	478	19.1	104	29.97	29.96	116

Table B-18. Detonation-Onset Engine Parameters, Part 18

Blend	Fuel Temperature (°F)	Fuel Density (lb/gal)	Metered Fuel Pressure (psi)	Unmetered Fuel Pressure (psi)	CHT 1 (°F)	CHT 2 (°F)	CHT 3 (°F)
8	64	6.15	5.3	25.7	477	440	471
8	64	6.15	5.4	25.7	475	443	473
8	64	6.15	5.1	25.7	476	443	471
8	64	6.15	5.4	25.7	475	442	468
8	64	6.15	5.5	25.7	476	443	476
8	64	6.15	3.9	25.7	476	446	466
8	64	6.15	4.0	25.7	475	447	464
8	64	6.15	3.0	25.7	470	442	463
8	64	6.15	3.0	25.7	471	444	461
8	64	6.15	3.0	25.7	467	439	458
8	64	6.15	2.0	25.7	465	437	457
9	63	6.34	7.0	25.8	473	437	468
9	63	6.33	7.0	25.7	477	441	471
9	64	6.34	4.8	25.8	475	442	465
9	64	6.33	4.7	25.8	478	442	464
9	63	6.33	5.1	25.8	475	444	465
9	63	6.34	4.9	25.8	476	445	467
9	63	6.34	3.6	25.7	471	443	466
9	63	6.34	3.9	25.7	470	441	463
9	63	6.34	3.9	25.7	470	441	463
9	63	6.33	3.5	25.7	471	443	464
9	63	6.33	3.6	25.7	471	443	464
9	64	6.33	2.8	25.7	467	438	459
9	63	6.33	2.6	25.7	466	439	457
9	63	6.33	2.7	25.7	463	436	455
9	63	6.33	2.9	25.7	467	439	458
9	63	6.34	6.7	25.8	479	439	470
9	63	6.34	4.9	25.8	475	444	467

CHT = Cylinder head temperature

Table B-19. Detonation-Onset Engine Parameters, Part 19

Blend	CHT 4 (°F)	CHT 5 (°F)	CHT 6 (°F)	EGT 1 (°F)	EGT 2 (°F)	EGT 3 (°F)	EGT 4 (°F)
8	459	466	477	1572	1515	1624	1559
8	460	468	480	1566	1508	1613	1546
8	460	467	481	1585	1532	1634	1570
8	460	468	480	1565	1509	1620	1551
8	461	470	477	1563	1510	1610	1551
8	461	467	475	1554	1512	1610	1550
8	462	465	476	1558	1513	1610	1552
8	459	466	475	1525	1491	1572	1527
8	461	465	476	1525	1494	1573	1525
8	456	461	475	1517	1486	1568	1518
8	455	461	475	1532	1520	1558	1544
9	459	464	478	1517	1464	1566	1500
9	459	469	476	1506	1458	1561	1491
9	457	462	476	1502	1462	1560	1496
9	459	462	473	1507	1466	1566	1501
9	459	464	476	1479	1444	1540	1475
9	460	466	475	1498	1458	1557	1496
9	461	468	476	1482	1449	1535	1485
9	459	464	477	1453	1423	1508	1460
9	459	465	478	1450	1420	1505	1458
9	461	468	476	1481	1449	1532	1484
9	461	466	476	1477	1447	1529	1482
9	458	463	475	1460	1438	1516	1472
9	457	465	475	1478	1454	1528	1485
9	455	458	474	1454	1429	1508	1467
9	458	464	476	1455	1430	1504	1460
9	458	466	477	1523	1475	1576	1509
9	465	464	475	1487	1453	1548	1489

CHT = Cylinder head temperature
EGT = Exhaust gas temperature

Table B-20. Detonation-Onset Engine Parameters, Part 20

Blend	EGT 5 (°F)	EGT 6 (°F)	Oil Inlet Temperature (°F)	Oil Pressure (psi)	Engine Inlet Air Humidity Ratio (Gr/lb)	Engine Inlet Air Relative Humidity (%)	Engine Intake Airflow (lb/hr)
8	1595	1561	230	67	0.4	0	1693
8	1591	1552	230	66	0.4	0	1690
8	1611	1577	242	67	0.4	0	1690
8	1596	1554	232	67	0.4	0	1693
8	1588	1554	223	67	0.4	0	1692
8	1592	1556	241	65	0.4	0	1453
8	1591	1555	239	65	0.4	0	1458
8	1552	1532	231	63	0.4	0	1280
8	1553	1536	242	63	0.4	0	1281
8	1546	1525	243	63	0.4	0	1289
8	1549	1544	242	61	0.3	0	1125
9	1535	1497	223	67	0.3	0	1709
9	1527	1496	239	66	0.3	0	1704
9	1538	1498	233	65	0.3	0	1444
9	1544	1509	225	65	0.3	0	1444
9	1519	1474	240	65	0.3	0	1453
9	1534	1494	237	65	0.3	0	1452
9	1512	1491	224	63	0.3	0	1280
9	1481	1467	239	61	0.3	0	1286
9	1481	1464	236	63	0.3	0	1277
9	1508	1489	238	63	0.3	0	1277
9	1505	1487	242	62	0.3	0	1272
9	1493	1482	243	61	0.3	0	1121
9	1504	1493	238	61	0.2	0	1121
9	1484	1473	243	61	0.3	0	1117
9	1481	1470	234	61	0.3	0	1116
9	1548	1511	241	66	0.3	0	1710
9	1530	1486	242	65	0.3	0	1454

EGT = Exhaust gas temperature
Gr = Grains of moisture per pound of dry air

Table B-21. Detonation-Onset Engine Parameters, Part 21

Blend	Fuel Flow (lb/hr)	Brake Horsepower	Air-to-Fuel Ratio (average)	Equivalence Ratio	Brake-Specific Fuel Consumption (lb/hp hr)	Manifold Absolute Pressure (inHg)	Brake Mean Effective Pressure (psi)
10	134.9	272.8	12.35	1.116	0.495	29.47	147.8
10	132.5	272.5	12.60	1.100	0.486	29.47	147.6
10	133.2	271.9	12.40	1.110	0.490	29.46	147.3
10	130.5	270.7	12.63	1.091	0.482	29.47	146.7
10	107.7	232.2	13.18	1.046	0.464	27.46	130.7
10	109.1	233.4	13.07	1.054	0.468	27.45	131.3
10	108.3	232.0	13.18	1.046	0.467	27.47	130.5
10	108.6	232.5	13.07	1.054	0.467	27.46	130.8
10	111.1	233.0	12.84	1.073	0.477	27.46	131.1
10	95.2	205.7	13.20	1.040	0.463	26.18	124.5
10	94.8	203.4	13.37	1.031	0.466	26.18	121.5
10	92.9	203.5	13.44	1.026	0.456	26.19	121.5
10	91.8	202.2	13.53	1.019	0.454	26.19	120.7
10	96.7	206.2	13.07	1.054	0.469	26.19	123.1
10	82.1	173.2	13.19	1.045	0.474	23.91	107.8
10	80.2	173.0	13.71	1.005	0.463	24.34	107.7
10	81.3	175.0	13.43	1.026	0.464	24.33	109.0
10	132.0	271.7	12.49	1.103	0.486	29.47	147.2

Table B-22. Detonation-Onset Engine Parameters, Part 22

Blend	Engine Speed (rpm)	Engine Torque (ft-lb)	Fuel Flow (gal/hr)	Engine Inlet Air Temperature (°F)	Engine Inlet Air Pressure (inHg)	Test Cell Barometer (inHg)	Engine Cowling Temperature (°F)
10	2699	531	21.6	102	29.97	29.97	110
10	2699	530	21.3	103	29.97	29.97	113
10	2699	529	21.4	105	29.97	29.97	114
10	2699	527	20.9	104	29.97	29.97	114
10	2600	469	17.4	105	29.96	29.97	114
10	2600	471	17.5	104	29.95	29.97	113
10	2600	469	17.4	104	29.98	29.97	115
10	2600	470	17.4	104	29.97	29.97	113
10	2600	471	17.8	104	29.97	29.98	115
10	2450	441	15.3	103	29.96	29.98	114
10	2450	439	15.1	104	29.98	29.98	113
10	2450	436	14.9	104	29.96	29.98	116
10	2450	434	14.7	103	29.97	29.98	114
10	2450	442	15.5	104	29.97	29.97	113
10	2350	387	13.2	104	29.97	29.97	116
10	2350	390	12.9	103	29.96	29.97	114
10	2349	391	13.0	103	29.96	29.97	115
10	2699	529	21.2	105	29.97	29.97	112

Table B-23. Detonation-Onset Engine Parameters, Part 23

Blend	Fuel Temperature (°F)	Fuel Density (lb/gal)	Metered Fuel Pressure (psi)	Unmetered Fuel Pressure (psi)	CHT 1 (°F)	CHT 2 (°F)	CHT 3 (°F)
10	64	6.24	6.2	25.7	476	443	477
10	64	6.24	6.1	25.7	476	444	470
10	64	6.24	6.0	25.7	476	444	472
10	64	6.24	5.8	25.7	478	445	471
10	64	6.24	4.1	25.7	476	449	471
10	64	6.24	4.1	25.7	476	447	465
10	64	6.24	4.0	25.7	476	451	469
10	64	6.24	4.1	25.7	480	448	466
10	63	6.24	4.2	25.7	476	449	466
10	63	6.24	3.1	25.6	474	443	463
10	64	6.24	3.0	25.6	470	443	461
10	64	6.24	3.0	25.6	474	445	462
10	64	6.24	2.9	25.6	470	443	460
10	64	6.24	3.2	25.6	471	443	460
10	64	6.24	2.3	25.6	469	441	460
10	64	6.24	2.2	25.6	468	442	460
10	64	6.24	2.3	25.6	467	442	457
10	64	6.24	6.0	25.7	476	444	477

CHT = Cylinder head temperature

Table B-24. Detonation-Onset Engine Parameters, Part 24

Blend	CHT 4 (°F)	CHT 5 (°F)	CHT 6 (°F)	EGT 1 (°F)	EGT 2 (°F)	EGT 3 (°F)	EGT 4 (°F)
10	460	468	477	1559	1498	1602	1542
10	461	469	477	1561	1504	1607	1546
10	461	470	478	1556	1503	1608	1547
10	463	472	479	1572	1516	1625	1558
10	463	468	475	1552	1513	1611	1551
10	462	466	474	1560	1512	1610	1550
10	464	469	477	1563	1514	1616	1556
10	462	465	475	1557	1510	1613	1547
10	463	469	475	1541	1497	1597	1535
10	462	468	475	1521	1488	1573	1524
10	466	464	477	1532	1499	1584	1538
10	465	466	479	1540	1505	1588	1546
10	463	464	475	1544	1515	1585	1553
10	462	466	476	1509	1478	1566	1518
10	460	463	475	1502	1481	1549	1511
10	460	465	475	1531	1504	1565	1533
10	461	463	475	1521	1503	1566	1523
10	462	469	480	1561	1509	1611	1549

CHT = Cylinder head temperature
EGT = Exhaust gas temperature

Table B-25. Detonation-Onset Engine Parameters, Part 25

Blend	EGT 5 (°F)	EGT 6 (°F)	Oil Inlet Temperature (°F)	Oil Pressure (psi)	Engine Inlet Air Humidity Ratio (Gr/lb)	Engine Inlet Air Relative Humidity (%)	Engine Intake Airflow (lb/hr)
10	1578	1538	229	65	0.3	0	1708
10	1583	1543	223	65	0.3	0	1703
10	1582	1546	238	65	0.3	0	1700
10	1600	1556	244	64	0.4	0	1703
10	1588	1557	238	64	0.3	0	1434
10	1591	1557	231	64	0.3	0	1436
10	1601	1559	230	64	0.3	0	1436
10	1589	1552	238	64	0.3	0	1439
10	1576	1540	224	64	0.3	0	1435
10	1548	1533	244	62	0.3	0	1273
10	1564	1539	246	61	0.3	0	1275
10	1571	1551	244	61	0.3	0	1264
10	1573	1559	238	62	0.3	0	1274
10	1540	1525	239	62	0.3	0	1272
10	1529	1513	239	60	0.3	0	1081
10	1552	1539	238	60	0.3	0	1109
10	1545	1530	240	60	0.3	0	1104
10	1585	1546	241	64	0.3	0	1701

EGT = Exhaust gas temperature
Gr = Grains of moisture per pound of dry air

Table B-26. Detonation-Onset Engine Parameters, Part 26

Blend	Fuel Flow (lb/hr)	Brake Horsepower	Air-to-Fuel Ratio (average)	Equivalence Ratio	Brake-Specific Fuel Consumption (lb/hp hr)	Manifold Absolute Pressure (inHg)	Brake Mean Effective Pressure (psi)
11	159.4	271.0	10.76	1.278	0.588	29.49	146.9
11	156.2	271.7	10.92	1.259	0.575	29.49	147.3
11	159.1	270.6	10.75	1.279	0.588	29.48	146.7
11	134.3	233.8	11.03	1.247	0.574	27.37	131.6
11	134.8	234.0	10.99	1.252	0.576	27.35	131.7
11	132.3	233.6	11.14	1.234	0.567	27.37	131.3
11	133.6	233.7	11.04	1.246	0.570	27.36	131.5
11	116.5	207.1	11.21	1.227	0.562	26.09	123.7
11	120.1	206.2	10.93	1.258	0.583	26.11	123.2
11	119.1	207.0	11.05	1.245	0.575	26.10	123.7
11	117.7	206.5	11.08	1.242	0.570	26.11	123.3
11	102.0	180.0	11.24	1.223	0.565	24.37	112.1
11	100.7	180.6	11.40	1.210	0.558	24.42	112.4
11	103.5	177.9	11.12	1.237	0.582	24.23	110.8
11	102.1	179.8	11.21	1.227	0.568	24.30	111.9
11	100.7	179.8	11.34	1.213	0.560	24.34	112.0

Table B-27. Detonation-Onset Engine Parameters, Part 27

Blend	Engine Speed (rpm)	Engine Torque (ft-lb)	Fuel Flow (gal/hr)	Engine Inlet Air Temperature (°F)	Engine Inlet Air Pressure (inHg)	Test Cell Barometer (inHg)	Engine Cowling Temperature (°F)
11	2699	527	25.4	103	29.99	29.97	114
11	2699	529	24.9	104	29.98	29.97	114
11	2699	527	25.3	104	29.98	29.97	116
11	2599	473	21.8	103	29.97	29.97	115
11	2599	473	21.5	104	29.97	29.97	113
11	2599	473	21.2	104	29.97	29.97	116
11	2599	473	21.4	104	29.98	29.97	115
11	2449	444	18.6	104	29.96	29.97	114
11	2449	442	19.1	104	29.97	29.97	115
11	2449	444	19.0	104	29.97	29.97	116
11	2449	443	18.8	104	29.97	29.97	115
11	2349	402	16.3	104	29.98	29.97	115
11	2349	404	16.1	104	29.97	29.97	116
11	2349	398	16.5	104	29.97	29.97	115
11	2349	402	16.3	104	29.96	29.97	116
11	2349	402	16.0	103	29.98	29.97	116

Table B-28. Detonation-Onset Engine Parameters, Part 28

Blend	Fuel Temperature (°F)	Fuel Density (lb/gal)	Metered Fuel Pressure (psi)	Unmetered Fuel Pressure (psi)	CHT 1 (°F)	CHT 2 (°F)	CHT 3 (°F)
11	66	6.28	8.5	25.6	480	440	471
11	66	6.28	8.2	25.6	479	438	475
11	66	6.28	8.5	25.6	478	442	476
11	67	6.28	6.0	25.6	475	443	477
11	67	6.28	6.0	25.6	475	443	469
11	67	6.28	5.9	25.6	475	445	469
11	67	6.28	6.0	25.6	475	444	473
11	67	6.28	4.5	25.5	475	442	468
11	67	6.28	4.8	25.5	472	442	467
11	67	6.27	4.7	25.5	468	438	463
11	67	6.27	4.7	25.5	468	438	463
11	67	6.27	3.5	25.5	469	440	463
11	68	6.27	3.4	25.5	470	441	464
11	68	6.27	3.6	25.5	467	441	464
11	67	6.27	3.5	25.5	469	440	463
11	67	6.27	3.4	25.5	467	439	461

CHT = Cylinder head temperature

Table B-29. Detonation-Onset Engine Parameters, Part 29

Blend	CHT 4 (°F)	CHT 5 (°F)	CHT 6 (°F)	EGT 1 (°F)	EGT 2 (°F)	EGT 3 (°F)	EGT 4 (°F)
11	464	465	476	1444	1395	1490	1429
11	458	463	474	1457	1407	1505	1443
11	461	470	476	1439	1399	1493	1433
11	459	463	473	1411	1379	1470	1414
11	458	464	472	1413	1378	1473	1415
11	459	467	473	1425	1390	1480	1424
11	459	466	472	1421	1383	1474	1418
11	460	465	475	1391	1366	1448	1400
11	461	467	475	1381	1354	1434	1388
11	458	464	475	1384	1361	1440	1391
11	457	464	475	1385	1358	1436	1388
11	458	462	474	1389	1365	1439	1394
11	460	463	476	1396	1371	1448	1401
11	458	467	476	1381	1354	1431	1383
11	457	463	475	1388	1359	1435	1389
11	456	463	475	1392	1365	1442	1399

CHT = Cylinder head temperature
EGT = Exhaust gas temperature

Table B-30. Detonation-Onset Engine Parameters, Part 30

Blend	EGT 5 (°F)	EGT 6 (°F)	Oil Inlet Temperature (°F)	Oil Pressure (psi)	Engine Inlet Air Humidity Ratio (Gr/lb)	Engine Inlet Air Relative Humidity (%)	Engine Intake Airflow (lb/hr)
11	1461	1428	243	64	0.3	0	1726
11	1472	1439	242	64	0.3	0	1719
11	1461	1434	243	64	0.3	0	1712
11	1452	1419	245	63	0.3	0	1439
11	1448	1418	227	63	0.3	0	1441
11	1458	1430	243	63	0.3	0	1451
11	1448	1423	239	63	0.3	0	1437
11	1418	1402	241	61	0.3	0	1269
11	1405	1394	239	61	0.3	0	1278
11	1411	1391	243	61	0.3	0	1272
11	1410	1391	241	61	0.3	0	1269
11	1412	1401	246	59	0.3	0	1122
11	1416	1409	240	60	0.3	0	1116
11	1398	1391	242	60	0.3	0	1106
11	1406	1397	239	60	0.3	0	1115
11	1418	1403	224	60	0.3	0	1115

EGT = Exhaust gas temperature
Gr = Grains of moisture per pound of dry air

Table B-31. Detonation-Onset Engine Parameters, Part 31

Blend	Fuel Flow (lb/hr)	Brake Horsepower	Air-to-Fuel Ratio (average)	Equivalence Ratio	Brake-Specific Fuel Consumption (lb/hp hr)	Manifold Absolute Pressure (inHg)	Brake Mean Effective Pressure (psi)
12	148.1	272.8	11.47	1.222	0.543	29.51	147.8
12	150.9	272.0	11.27	1.245	0.555	29.50	147.4
12	152.3	270.1	11.19	1.253	0.564	29.49	146.4
12	151.7	271.0	11.21	1.251	0.560	29.49	146.9
12	150.4	271.2	11.32	1.239	0.555	29.48	146.9
12	128.5	235.5	11.50	1.220	0.545	27.51	132.7
12	125.7	235.8	11.70	1.200	0.533	27.49	132.8
12	129.0	236.0	11.47	1.222	0.547	27.48	132.8
12	125.6	236.4	11.72	1.197	0.531	27.50	133.1
12	130.7	235.7	11.31	1.240	0.554	27.49	132.6
12	112.8	210.6	11.63	1.206	0.535	26.35	125.8
12	111.2	208.8	11.60	1.200	0.533	26.24	124.5
12	114.6	208.1	11.39	1.231	0.552	26.22	124.3
12	114.7	207.9	11.42	1.228	0.552	26.21	124.1
12	108.8	209.0	11.87	1.181	0.521	26.22	124.8
12	97.1	181.1	11.85	1.184	0.535	24.41	112.8
12	94.4	181.3	12.05	1.164	0.520	24.39	113.1
12	98.4	180.2	11.59	1.210	0.546	24.39	112.2
12	95.5	180.2	11.92	1.177	0.528	24.38	112.2
12	99.5	180.0	11.53	1.216	0.551	24.37	112.1

Table B-32. Detonation-Onset Engine Parameters, Part 32

Blend	Engine Speed (rpm)	Engine Torque (ft-lb)	Fuel Flow (gal/hr)	Engine Inlet Air Temperature (°F)	Engine Inlet Air Pressure (inHg)	Test Cell Barometer (inHg)	Engine Cowling Temperature (°F)
12	2699	531	23.9	104	29.99	29.97	114
12	2699	529	24.3	104	29.99	29.96	116
12	2699	526	24.6	104	29.98	29.96	116
12	2699	527	24.5	104	29.97	29.96	114
12	2699	528	24.4	104	29.96	29.96	115
12	2599	476	20.7	104	29.96	29.96	116
12	2599	477	20.5	104	29.95	29.96	114
12	2599	477	20.8	104	29.95	29.96	115
12	2598	478	20.3	104	29.97	29.96	115
12	2599	476	21.1	104	29.96	29.96	115
12	2449	450	18.3	104	29.96	29.96	115
12	2449	447	18.0	104	29.97	29.96	116
12	2449	447	18.5	104	29.96	29.96	114
12	2449	445	18.9	104	29.95	29.96	115
12	2449	448	17.6	104	29.95	29.96	115
12	2349	405	15.8	104	29.97	29.96	116
12	2349	405	15.2	104	29.96	29.96	115
12	2349	403	15.9	104	29.96	29.96	115
12	2349	403	15.5	104	29.95	29.96	116
12	2349	403	16.1	103	29.94	29.96	116

Table B-33. Detonation-Onset Engine Parameters, Part 33

Blend	Fuel Temperature (°F)	Fuel Density (lb/gal)	Metered Fuel Pressure (psi)	Unmetered Fuel Pressure (psi)	CHT 1 (°F)	CHT 2 (°F)	CHT 3 (°F)
12	65	6.2	7.4	25.6	475	442	472
12	65	6.2	7.8	25.6	477	444	476
12	65	6.2	7.9	25.6	477	444	474
12	65	6.2	7.9	25.6	478	443	475
12	65	6.2	7.7	25.6	480	442	473
12	65	6.2	5.6	25.6	476	446	470
12	65	6.2	5.4	25.6	476	448	470
12	65	6.2	5.6	25.6	475	447	468
12	66	6.2	5.3	25.6	476	446	466
12	66	6.2	5.8	25.6	475	445	466
12	66	6.2	4.4	25.6	473	445	468
12	66	6.2	4.2	25.6	475	446	467
12	66	6.2	4.5	25.5	474	447	467
12	66	6.22	4.5	25.5	475	448	469
12	66	6.2	4.0	25.6	474	446	465
12	66	6.21	3.1	25.5	467	442	461
12	66	6.2	3.1	25.5	470	443	461
12	66	6.2	3.3	25.5	470	444	461
12	66	6.2	3.1	25.5	468	444	461
12	66	6.2	3.3	25.5	467	442	460

CHT = Cylinder head temperature

Table B-34. Detonation-Onset Engine Parameters, Part 34

Blend	CHT 4 (°F)	CHT 5 (°F)	CHT 6 (°F)	EGT 1 (°F)	EGT 2 (°F)	EGT 3 (°F)	EGT 4 (°F)
12	460	467	476	1473	1425	1521	1463
12	462	471	478	1463	1412	1511	1451
12	461	467	476	1457	1406	1504	1443
12	461	468	474	1456	1409	1504	1446
12	459	468	473	1467	1413	1511	1449
12	467	465	471	1433	1396	1491	1431
12	463	467	473	1445	1410	1504	1442
12	461	467	471	1428	1392	1488	1430
12	459	465	470	1448	1406	1500	1443
12	460	466	473	1426	1385	1478	1421
12	463	467	476	1400	1376	1455	1414
12	462	471	472	1404	1373	1456	1413
12	465	472	474	1394	1365	1446	1402
12	465	473	475	1390	1358	1441	1396
12	465	469	474	1423	1390	1472	1427
12	457	462	475	1402	1377	1458	1408
12	460	462	475	1414	1385	1465	1420
12	460	463	475	1396	1367	1447	1400
12	459	464	474	1410	1381	1461	1417
12	460	464	475	1385	1358	1436	1395

CHT = Cylinder head temperature
EGT = Exhaust gas temperature

Table B-35. Detonation-Onset Engine Parameters, Part 35

Blend	EGT 5 (°F)	EGT 6 (°F)	Oil Inlet Temperature (°F)	Oil Pressure (psi)	Engine Inlet Air Humidity Ratio (Gr/lb)	Engine Inlet Air Relative Humidity (%)	Engine Intake Airflow (lb/hr)
12	1493	1462	232	63	0.3	0	1716
12	1483	1447	245	63	0.3	0	1708
12	1477	1442	241	64	0.3	0	1707
12	1476	1444	244	63	0.3	0	1716
12	1480	1449	244	63	0.3	0	1711
12	1467	1438	238	62	0.3	0	1451
12	1478	1444	245	62	0.3	0	1446
12	1462	1432	242	63	0.3	0	1445
12	1479	1443	230	63	0.3	0	1452
12	1455	1420	248	62	0.3	0	1446
12	1433	1415	244	61	0.3	0	1291
12	1431	1413	237	60	0.3	0	1281
12	1420	1407	236	61	0.3	0	1279
12	1416	1401	247	60	0.3	0	1286
12	1448	1431	234	61	0.3	0	1280
12	1426	1419	244	60	0.3	0	1120
12	1437	1428	245	60	0.3	0	1107
12	1421	1404	228	61	0.3	0	1111
12	1436	1418	228	60	0.3	0	1116
12	1409	1403	242	60	0.3	0	1122

EGT = Exhaust gas temperature
Gr = Grains of moisture per pound of dry air

Table B-36. Detonation-Onset Engine Parameters, Part 36

Blend	Fuel Flow (lb/hr)	Brake Horsepower	Air-to-Fuel Ratio (average)	Equivalence Ratio	Brake-Specific Fuel Consumption (lb/hp hr)	Manifold Absolute Pressure (inHg)	Brake Mean Effective Pressure (psi)
13	147.5	272.2	11.55	1.245	0.542	29.68	147.6
13	149.4	272.2	11.50	1.250	0.548	29.67	147.6
13	149.7	273.9	11.45	1.255	0.548	29.67	148.5
13	149.0	273.6	11.46	1.254	0.545	29.67	148.5
13	144.5	273.7	11.77	1.221	0.527	29.67	148.4
13	151.4	274.8	11.42	1.258	0.551	29.80	148.9
13	144.6	276.1	11.85	1.213	0.523	29.80	149.5
13	144.7	276.2	11.80	1.220	0.524	29.80	149.9
13	123.5	236.8	11.92	1.206	0.520	27.55	133.3
13	122.0	237.3	12.06	1.192	0.514	27.57	133.5
13	120.5	237.6	12.14	1.184	0.507	27.55	133.7
13	121.9	238.2	12.03	1.195	0.512	27.56	134.0
13	124.5	237.3	11.84	1.214	0.525	27.56	133.5
13	108.3	209.0	12.02	1.196	0.518	26.27	124.8
13	105.3	209.6	12.32	1.167	0.503	26.29	125.2
13	108.5	209.8	12.07	1.191	0.517	26.29	125.3
13	107.6	209.3	12.05	1.193	0.513	26.30	124.9
13	104.4	209.8	12.46	1.154	0.498	26.30	125.3
13	90.5	180.6	12.45	1.155	0.502	24.31	112.4
13	95.3	181.8	12.05	1.193	0.524	24.55	113.2
13	93.2	182.6	12.28	1.171	0.510	24.54	113.7
13	97.7	181.5	11.79	1.219	0.538	24.54	113.0
13	94.7	182.0	12.07	1.191	0.519	24.55	113.3
13	124.7	235.4	11.79	1.219	0.530	27.52	132.5

Table B-37. Detonation-Onset Engine Parameters, Part 37

Blend	Engine Speed (rpm)	Engine Torque (ft-lb)	Fuel Flow (gal/hr)	Engine Inlet Air Temperature (°F)	Engine Inlet Air Pressure (inHg)	Test Cell Barometer (inHg)	Engine Cowling Temperature (°F)
13	2697	530	24.7	106	30.19	30.19	115
13	2697	530	25.0	104	30.19	30.19	114
13	2697	533	24.6	100	30.18	30.19	114
13	2697	532	25.0	101	30.18	30.19	115
13	2697	533	24.0	103	30.18	30.19	117
13	2699	535	24.8	106	30.31	30.29	114
13	2700	537	23.5	105	30.31	30.29	116
13	2700	538	23.8	106	30.31	30.29	115
13	2599	479	20.2	106	30.32	30.3	113
13	2599	479	19.9	106	30.31	30.3	116
13	2599	480	19.7	106	30.3	30.3	116
13	2599	481	19.9	106	30.3	30.3	114
13	2600	479	20.3	106	30.31	30.29	117
13	2449	448	17.7	106	30.34	30.32	116
13	2449	449	17.2	105	30.34	30.32	115
13	2449	448	17.8	104	30.35	30.33	116
13	2450	449	17.7	103	30.34	30.33	117
13	2449	450	17.0	103	30.35	30.33	116
13	2349	404	14.8	102	30.33	30.33	116
13	2350	406	15.6	105	30.34	30.33	115
13	2349	408	15.2	105	30.33	30.33	116
13	2349	406	16.0	106	30.32	30.33	116
13	2350	407	15.5	108	30.34	30.32	115
13	2597	476	20.6	105	30.17	30.19	116

Table B-38. Detonation-Onset Engine Parameters, Part 38

Blend	Fuel Temperature (°F)	Fuel Density (lb/gal)	Metered Fuel Pressure (psi)	Unmetered Fuel Pressure (psi)	CHT 1 (°F)	CHT 2 (°F)	CHT 3 (°F)
13	74	6.09	7.7	25.4	472	450	473
13	74	6.07	7.8	25.4	471	449	473
13	74	6.07	8.0	25.4	471	449	475
13	74	6.06	7.9	25.4	474	449	476
13	74	6.05	7.3	25.4	476	452	476
13	64	6.12	8.1	25.6	470	444	469
13	61	6.13	7.4	25.6	469	445	470
13	62	6.13	7.6	25.6	468	444	469
13	62	6.13	5.6	25.6	466	448	465
13	62	6.13	5.5	25.6	468	451	467
13	63	6.12	5.3	25.6	467	450	466
13	63	6.12	5.4	25.6	467	450	467
13	64	6.12	5.6	25.6	466	449	464
13	62	6.13	4.4	25.6	462	444	459
13	62	6.13	4.2	25.6	458	441	457
13	62	6.13	4.4	25.6	461	444	460
13	63	6.13	4.4	25.6	461	444	461
13	63	6.12	4.1	25.6	461	443	461
13	65	6.12	3.2	25.5	461	445	460
13	65	6.12	3.5	25.5	462	447	461
13	65	6.11	3.3	25.5	464	447	461
13	63	6.12	3.6	25.5	463	446	459
13	62	6.13	3.4	25.5	460	445	459
13	74	6.07	5.6	25.4	477	452	475

CHT = Cylinder head temperature

Table B-39. Detonation-Onset Engine Parameters, Part 39

Blend	CHT 4 (°F)	CHT 5 (°F)	CHT 6 (°F)	EGT 1 (°F)	EGT 2 (°F)	EGT 3 (°F)	EGT 4 (°F)
13	467	470	476	1450	1407	1504	1442
13	466	468	475	1454	1407	1502	1443
13	467	471	475	1448	1412	1497	1439
13	468	472	476	1453	1407	1499	1439
13	469	470	476	1475	1427	1520	1460
13	455	466	476	1451	1399	1494	1432
13	456	466	476	1476	1425	1524	1461
13	456	468	476	1468	1418	1515	1452
13	460	465	476	1441	1400	1490	1432
13	461	469	476	1444	1409	1500	1441
13	459	469	475	1454	1414	1507	1445
13	459	470	476	1443	1410	1499	1439
13	458	468	475	1437	1395	1489	1428
13	463	464	476	1404	1376	1453	1407
13	460	463	477	1422	1394	1471	1424
13	463	464	475	1402	1376	1449	1405
13	464	463	477	1413	1384	1458	1413
13	463	463	476	1431	1405	1479	1435
13	463	463	475	1423	1393	1464	1420
13	466	465	476	1401	1374	1447	1401
13	466	464	477	1414	1389	1461	1413
13	464	463	475	1390	1361	1434	1387
13	463	462	475	1402	1378	1446	1402
13	463	471	475	1431	1400	1485	1426

CHT = Cylinder head temperature
EGT = Exhaust gas temperature

Table B-40. Detonation-Onset Engine Parameters, Part 40

Blend	EGT 5 (°F)	EGT 6 (°F)	Oil Inlet Temperature (°F)	Oil Pressure (psi)	Engine Inlet Air Humidity Ratio (Gr/lb)	Engine Inlet Air Relative Humidity (%)	Engine Intake Airflow (lb/hr)
13	1473	1438	243	66	-0.1	0	1716
13	1475	1433	238	66	-0.1	0	1729
13	1465	1433	224	66	-0.1	0	1744
13	1465	1436	243	65	0.2	0	1730
13	1487	1456	231	66	0	0	1730
13	1466	1433	232	64	0	0	1730
13	1493	1460	235	65	0.1	0	1737
13	1487	1452	229	65	0.2	0	1741
13	1463	1437	228	64	0.1	0	1457
13	1473	1444	232	64	0	0	1449
13	1478	1449	240	64	0	0	1456
13	1472	1444	212	64	0.2	0	1446
13	1462	1429	227	64	0.2	0	1460
13	1429	1411	237	62	0.3	0	1282
13	1445	1431	226	62	0.3	0	1286
13	1429	1415	234	63	0.2	0	1282
13	1436	1420	233	63	0.3	0	1300
13	1458	1442	230	62	0.2	0	1288
13	1443	1432	241	61	0.2	0	1114
13	1423	1413	235	61	0.2	0	1127
13	1436	1429	239	61	0.2	0	1131
13	1411	1401	228	62	0	0	1127
13	1423	1413	238	61	0.1	0	1124
13	1459	1429	233	65	0	0	1442

EGT = Exhaust gas temperature
Gr = Grains of moisture per pound of dry air

Table B-41. Detonation-Onset Engine Parameters, Part 41

Blend	Fuel Flow (lb/hr)	Brake Horsepower	Air-to-Fuel Ratio (average)	Equivalence Ratio	Brake-Specific Fuel Consumption (lb/hp hr)	Manifold Absolute Pressure (inHg)	Brake Mean Effective Pressure (psi)
14	133.2	274.5	12.48	1.085	0.485	29.70	148.8
14	136.0	276.3	12.24	1.105	0.493	29.72	150.0
14	133.0	275.0	12.46	1.086	0.484	29.72	149.1
14	134.9	277.7	12.40	1.091	0.486	29.82	150.4
14	137.1	277.6	12.32	1.099	0.494	29.81	150.4
14	111.0	233.2	12.73	1.063	0.476	27.29	131.2
14	109.1	232.1	12.87	1.052	0.470	27.31	130.7
14	112.4	234.0	12.55	1.078	0.480	27.17	131.7
14	111.4	233.2	12.62	1.073	0.478	27.18	131.2
14	90.5	201.0	13.34	1.014	0.450	26.04	120.0
14	93.6	203.4	13.10	1.033	0.460	26.04	121.4
14	94.9	205.0	12.99	1.042	0.463	26.05	122.4
14	81.7	172.8	13.38	1.012	0.473	24.14	107.6
14	82.2	176.6	13.13	1.031	0.465	24.14	109.9
14	82.1	176.6	13.05	1.037	0.465	24.14	109.9
14	115.3	233.9	12.33	1.098	0.493	27.28	131.7
14	138.2	278.4	12.13	1.115	0.497	29.81	150.8
15	No Detonation						
16	135.1	276.8	12.60	1.154	0.488	29.79	150.0
16	132.9	276.5	12.97	1.121	0.482	29.81	150.0
16	134.7	276.1	12.65	1.150	0.488	29.80	149.7
16	135.0	276.1	12.50	1.163	0.489	29.80	149.6
16	135.7	276.1	12.50	1.164	0.492	29.80	149.7
16	111.7	237.5	12.99	1.119	0.470	27.62	133.7
16	109.4	237.6	13.30	1.094	0.460	27.63	133.7
16	102.3	211.2	12.76	1.140	0.485	26.35	126.1
16	100.5	211.0	12.91	1.127	0.476	26.37	126.0
16	96.2	210.7	13.28	1.095	0.457	26.37	125.8
16	99.1	211.1	13.00	1.119	0.470	26.36	126.1
16	100.4	211.3	12.89	1.128	0.475	26.39	126.2
16	87.4	183.1	13.09	1.111	0.477	24.50	114.0
16	82.5	181.4	13.68	1.063	0.455	24.52	113.0
16	84.1	182.0	13.50	1.077	0.462	24.52	113.3

Table B-42. Detonation-Onset Engine Parameters, Part 42

Blend	Engine Speed (rpm)	Engine Torque (ft-lb)	Fuel Flow (gal/hr)	Engine Inlet Air Temperature (°F)	Engine Inlet Air Pressure (inHg)	Test Cell Barometer (inHg)	Engine Cowling Temperature (°F)
14	2698	534	20.7	105	30.19	30.19	102
14	2698	539	21.1	103	30.2	30.19	103
14	2698	535	20.7	104	30.19	30.19	101
14	2700	540	20.8	105	30.31	30.29	117
14	2700	540	21.0	105	30.3	30.28	112
14	2599	471	17.3	104	30.19	30.19	102
14	2599	472	17.1	103	30.19	30.19	103
14	2600	473	17.3	105	30.29	30.28	113
14	2600	471	17.2	105	30.29	30.28	112
14	2450	431	13.9	105	30.29	30.28	112
14	2450	436	14.4	105	30.29	30.28	111
14	2450	439	14.6	105	30.29	30.28	112
14	2350	390	12.6	105	30.27	30.28	111
14	2350	395	12.7	104	30.28	30.28	111
14	2350	395	12.7	105	30.27	30.28	111
14	2598	475	18.1	104	30.18	30.19	103
14	2700	542	21.4	105	30.31	30.29	114
15	No Detonation						
16	2699	538	21.6	105	30.27	30.25	111
16	2699	539	20.9	105	30.27	30.25	112
16	2699	538	21.6	106	30.27	30.25	112
16	2699	537	21.9	106	30.27	30.25	111
16	2699	537	22.0	105	30.27	30.25	113
16	2599	480	18.0	105	30.25	30.25	112
16	2599	480	17.6	105	30.26	30.25	112
16	2449	453	16.5	105	30.24	30.25	113
16	2449	452	16.2	106	30.26	30.25	113
16	2449	452	15.7	105	30.25	30.25	111
16	2449	452	16.1	105	30.24	30.24	111
16	2449	453	16.2	105	30.25	30.24	113
16	2349	409	14.1	105	30.25	30.24	112
16	2349	407	13.4	105	30.24	30.24	112
16	2349	408	13.7	105	30.25	30.24	112

Table B-43. Detonation-Onset Engine Parameters, Part 43

Blend	Fuel Temperature (°F)	Fuel Density (lb/gal)	Metered Fuel Pressure (psi)	Unmetered Fuel Pressure (psi)	CHT 1 (°F)	CHT 2 (°F)	CHT 3 (°F)
14	75	6.42	6.0	25.7	473	452	470
14	75	6.42	6.3	25.7	475	450	470
14	75	6.42	6.0	25.8	475	450	470
14	60	6.49	6.2	25.9	473	450	472
14	61	6.48	6.3	25.9	470	448	467
14	76	6.41	4.2	25.7	473	453	467
14	76	6.41	4.2	25.7	475	454	465
14	61	6.48	4.4	25.9	471	450	465
14	60	6.49	4.4	25.9	468	450	462
14	62	6.51	3.0	25.9	463	446	456
14	62	6.48	3.2	25.8	463	445	461
14	60	6.49	3.3	25.8	463	445	457
14	61	6.49	2.5	25.8	460	443	455
14	61	6.48	2.6	25.8	456	439	450
14	62	6.48	2.6	25.8	456	439	450
14	75	6.42	4.6	25.7	479	454	469
14	59	6.51	6.6	25.9	471	448	469
15	No Detonation						
16	63	6.21	6.4	26	471	448	472
16	61	6.21	6.0	26	470	449	472
16	60	6.22	6.3	25.9	470	447	470
16	60	6.22	6.6	25.9	469	447	470
16	61	6.21	6.6	25.9	469	446	472
16	62	6.21	4.5	26	469	454	465
16	61	6.21	4.3	26	471	456	463
16	62	6.21	3.7	25.9	463	451	461
16	62	6.21	3.7	25.9	463	449	459
16	63	6.21	3.5	25.9	462	449	456
16	62	6.21	3.7	25.9	461	448	456
16	60	6.21	3.7	25.9	462	449	457
16	61	6.21	2.8	25.9	461	448	455
16	61	6.22	2.6	25.9	460	451	455
16	60	6.21	2.7	25.8	462	449	458

CHT = Cylinder head temperature

Table B-44. Detonation-Onset Engine Parameters, Part 44

Blend	CHT 4 (°F)	CHT 5 (°F)	CHT 6 (°F)	EGT 1 (°F)	EGT 2 (°F)	EGT 3 (°F)	EGT 4 (°F)
14	460	472	477	1586	1538	1633	1568
14	462	470	477	1575	1524	1624	1557
14	462	471	477	1586	1537	1640	1573
14	463	474	482	1581	1526	1630	1565
14	461	476	479	1574	1519	1626	1559
14	471	469	475	1556	1524	1613	1552
14	472	469	478	1566	1531	1621	1559
14	461	468	476	1543	1505	1600	1531
14	460	472	476	1549	1509	1604	1538
14	458	468	475	1561	1537	1594	1562
14	458	468	475	1550	1516	1593	1547
14	458	466	475	1539	1506	1586	1535
14	456	462	475	1536	1521	1574	1539
14	454	458	475	1530	1508	1570	1534
14	454	463	475	1526	1504	1568	1528
14	465	471	475	1528	1501	1586	1522
14	460	471	479	1562	1504	1609	1542
15	No Detonation						
16	459	468	477	1525	1466	1567	1507
16	460	470	478	1549	1491	1593	1536
16	463	468	477	1528	1475	1576	1517
16	458	466	477	1516	1461	1560	1496
16	457	467	477	1517	1459	1563	1500
16	458	472	475	1503	1466	1558	1497
16	458	473	476	1523	1485	1573	1517
16	458	466	475	1448	1423	1492	1448
16	456	465	475	1459	1433	1503	1458
16	457	464	476	1478	1448	1520	1474
16	456	463	476	1462	1432	1506	1458
16	456	464	475	1464	1431	1505	1458
16	452	462	475	1449	1433	1498	1456
16	453	461	475	1476	1461	1522	1480
16	452	462	475	1470	1451	1515	1474

CHT = Cylinder head temperature
EGT = Exhaust gas temperature

Table B-45. Detonation-Onset Engine Parameters, Part 45

Blend	EGT 5 (°F)	EGT 6 (°F)	Oil Inlet Temperature (°F)	Oil Pressure (psi)	Engine Inlet Air Humidity Ratio (Gr/lb)	Engine Inlet Air Relative Humidity (%)	Engine Intake Airflow (lb/hr)
14	1607	1568	228	66	0.1	0	1715
14	1595	1555	227	65	0.2	0	1720
14	1613	1570	236	64	0.2	0	1724
14	1600	1562	235	65	0.2	0	1731
14	1591	1557	234	65	0.3	0	1733
14	1588	1555	237	64	0.3	0	1428
14	1600	1562	225	64	0.3	0	1439
14	1567	1541	237	64	0.2	0	1429
14	1576	1545	234	64	0.3	0	1427
14	1583	1566	240	62	0.2	0	1268
14	1571	1553	224	63	0.3	0	1265
14	1562	1547	230	63	0.2	0	1265
14	1559	1547	238	61	0.3	0	1103
14	1549	1533	231	62	0.2	0	1104
14	1542	1533	236	62	0.3	0	1100
14	1560	1531	237	64	0.3	0	1437
14	1573	1544	240	64	0.1	0	1734
15	No Detonation						
16	1539	1506	244	63	0.2	0	1741
16	1567	1533	240	63	0.1	0	1718
16	1548	1513	224	64	0.2	0	1729
16	1535	1499	242	64	0.1	0	1737
16	1533	1499	241	64	0.3	0	1733
16	1534	1502	225	64	0.3	0	1460
16	1549	1517	228	63	0	0	1458
16	1474	1460	231	63	0.1	0	1293
16	1484	1465	239	62	0.2	0	1292
16	1503	1485	242	62	0.4	0	1293
16	1485	1466	227	62	0.3	0	1289
16	1485	1466	234	63	0.3	0	1290
16	1474	1462	238	61	0.1	0	1124
16	1500	1489	240	61	0.2	0	1132
16	1492	1478	230	61	0.2	0	1132

EGT = Exhaust gas temperature
Gr = Grains of moisture per pound of dry air

Table B-46. Detonation-Onset Engine Parameters, Part 46

Blend	Fuel Flow (lb/hr)	Brake Horsepower	Air-to-Fuel Ratio (average)	Equivalence Ratio	Brake-Specific Fuel Consumption (lb/hp hr)	Manifold Absolute Pressure (inHg)	Brake Mean Effective Pressure (psi)
17	139.5	277.8	12.20	1.149	0.502	29.77	150.5
17	141.4	277.7	12.04	1.164	0.509	29.78	150.5
17	143.4	277.9	11.94	1.174	0.516	29.78	150.6
17	141.9	278.8	12.10	1.160	0.509	29.78	150.5
17	142.6	277.5	12.01	1.167	0.514	29.77	150.4
17	116.3	235.0	12.50	1.120	0.495	27.18	132.3
17	119.4	236.2	12.19	1.150	0.505	27.28	133.0
17	118.4	236.1	12.27	1.142	0.502	27.28	132.8
17	115.6	236.0	12.51	1.120	0.489	27.29	132.9
17	104.0	209.9	12.33	1.137	0.495	26.08	125.4
17	101.4	209.6	12.59	1.113	0.484	26.08	125.2
17	102.5	209.8	12.58	1.114	0.489	26.09	125.3
17	101.7	209.8	12.56	1.116	0.484	26.09	125.3
17	104.4	210.4	12.36	1.134	0.496	26.14	125.6
17	88.2	179.4	12.62	1.110	0.492	24.11	111.7
17	89.6	182.4	12.60	1.110	0.491	24.34	113.6
17	88.0	178.5	12.60	1.110	0.493	23.97	111.2
17	90.0	181.2	12.47	1.123	0.496	24.30	112.8
18	153.5	269.5	11.30	1.270	0.570	29.72	146.0
18	155.3	269.9	11.19	1.282	0.576	29.73	146.2
18	153.9	270.1	11.26	1.274	0.570	29.72	146.4
18	152.5	270.2	11.32	1.267	0.565	29.73	146.4
18	131.1	235.8	11.50	1.247	0.556	27.81	132.7
18	131.1	235.5	11.50	1.250	0.556	27.82	132.3
18	132.4	234.9	11.40	1.260	0.564	27.82	132.1
18	115.3	208.6	11.56	1.241	0.553	26.47	124.6
18	115.1	208.6	11.57	1.239	0.552	26.49	124.6
18	115.5	209.1	11.60	1.240	0.552	26.49	124.8
18	113.6	208.7	11.72	1.224	0.544	26.50	124.6

Table B-47. Detonation-Onset Engine Parameters, Part 47

Blend	Engine Speed (rpm)	Engine Torque (ft-lb)	Fuel Flow (gal/hr)	Engine Inlet Air Temperature (°F)	Engine Inlet Air Pressure (inHg)	Test Cell Barometer (inHg)	Engine Cowling Temperature (°F)
17	2699	540	23.0	105	30.24	30.24	110
17	2699	540	23.4	105	30.25	30.24	112
17	2699	541	23.7	105	30.25	30.24	112
17	2699	541	23.5	105	30.25	30.24	109
17	2699	540	23.6	105	30.25	30.23	110
17	2598	475	19.2	105	30.26	30.24	111
17	2598	477	19.7	105	30.26	30.23	113
17	2599	477	19.6	105	30.24	30.24	113
17	2599	477	19.1	105	30.24	30.24	113
17	2449	450	17.2	105	30.25	30.24	111
17	2449	450	16.7	105	30.25	30.24	112
17	2449	450	16.9	105	30.26	30.24	113
17	2449	450	16.8	105	30.25	30.24	112
17	2450	451	17.2	105	30.22	30.23	108
17	2349	401	14.6	105	30.25	30.24	111
17	2349	408	14.8	104	30.25	30.24	113
17	2349	399	14.6	105	30.25	30.24	112
17	2349	405	14.9	105	30.23	30.23	108
18	2699	524	24.3	106	30.22	30.21	116
18	2699	525	24.6	105	30.22	30.21	115
18	2699	527	24.6	105	30.22	30.21	115
18	2699	526	24.2	105	30.21	30.21	117
18	2599	476	20.9	105	30.22	30.21	113
18	2599	475	20.9	106	30.21	30.2	114
18	2599	474	21.1	106	30.22	30.21	116
18	2449	448	18.4	105	30.21	30.21	116
18	2449	447	18.3	104	30.21	30.21	116
18	2449	448	18.3	105	30.21	30.2	116
18	2449	448	18.1	105	30.21	30.2	116

Table B-48. Detonation-Onset Engine Parameters, Part 48

Blend	Fuel Temperature (°F)	Fuel Density (lb/gal)	Metered Fuel Pressure (psi)	Unmetered Fuel Pressure (psi)	CHT 1 (°F)	CHT 2 (°F)	CHT 3 (°F)
17	60	6.06	7.0	25.8	473	452	468
17	61	6.05	7.2	25.8	473	452	469
17	61	6.05	7.3	25.8	473	453	469
17	62	6.05	7.3	25.7	473	452	468
17	63	6.05	7.3	25.8	471	452	468
17	61	6.05	4.9	25.8	466	452	459
17	62	6.05	5.2	25.8	465	455	461
17	62	6.05	5.1	25.8	465	454	459
17	60	6.05	4.9	25.8	469	456	463
17	62	6.05	4.1	25.7	462	447	457
17	60	6.05	3.9	25.8	461	447	456
17	60	6.06	3.9	25.7	460	447	456
17	60	6.06	3.9	25.7	460	448	456
17	60	6.05	4.0	25.7	463	452	461
17	60	6.05	3.0	25.8	462	451	457
17	60	6.05	3.1	25.8	461	451	456
17	62	6.05	3.0	25.7	461	450	455
17	61	6.05	3.1	25.7	460	451	458
18	62	6.32	8.2	25.6	468	454	468
18	63	6.29	8.3	25.7	467	454	468
18	64	6.29	8.2	25.7	471	454	470
18	63	6.29	8.0	25.7	468	455	471
18	63	6.29	6.0	25.5	470	461	466
18	63	6.29	6.0	25.5	469	459	470
18	63	6.29	6.1	25.5	470	461	464
18	62	6.3	4.8	25.6	465	453	464
18	62	6.29	4.7	25.6	464	456	463
18	63	6.29	4.7	25.6	465	454	465
18	63	6.29	4.6	25.7	463	456	465

CHT = Cylinder head temperature

Table B-49. Detonation-Onset Engine Parameters, Part 49

Blend	CHT 4 (°F)	CHT 5 (°F)	CHT 6 (°F)	EGT 1 (°F)	EGT 2 (°F)	EGT 3 (°F)	EGT 4 (°F)
17	454	469	478	1524	1466	1568	1509
17	454	469	479	1511	1459	1560	1499
17	455	469	481	1502	1451	1550	1492
17	452	467	480	1508	1458	1559	1498
17	453	468	478	1502	1451	1556	1495
17	451	463	478	1487	1450	1543	1480
17	454	464	476	1468	1437	1526	1467
17	453	464	476	1477	1444	1533	1475
17	455	467	476	1494	1459	1549	1490
17	452	468	475	1441	1414	1490	1442
17	453	464	475	1459	1433	1505	1459
17	452	464	476	1454	1431	1504	1458
17	452	464	476	1462	1437	1507	1462
17	451	468	475	1444	1420	1491	1446
17	452	461	475	1449	1431	1495	1453
17	452	461	475	1450	1430	1498	1455
17	452	460	475	1452	1435	1494	1455
17	449	466	475	1434	1419	1487	1439
18	451	471	475	1430	1383	1481	1425
18	451	470	475	1428	1380	1475	1421
18	450	472	475	1431	1378	1478	1423
18	451	475	476	1440	1385	1485	1433
18	451	475	475	1406	1370	1461	1406
18	450	475	474	1401	1369	1455	1406
18	451	473	475	1402	1366	1454	1401
18	451	473	474	1376	1353	1426	1382
18	450	469	475	1374	1356	1426	1384
18	450	468	475	1373	1354	1426	1383
18	449	469	475	1385	1366	1434	1391

CHT = Cylinder head temperature
EGT = Exhaust gas temperature

Table B-50. Detonation-Onset Engine Parameters, Part 50

Blend	EGT 5 (°F)	EGT 6 (°F)	Oil Inlet Temperature (°F)	Oil Pressure (psi)	Engine Inlet Air Humidity Ratio (Gr/lb)	Engine Inlet Air Relative Humidity (%)	Engine Intake Airflow (lb/hr)
17	1537	1503	236	65	0.4	0	1735
17	1527	1494	243	64	0.3	0	1737
17	1522	1487	239	64	0.3	0	1743
17	1528	1492	244	64	0.3	0	1734
17	1520	1490	241	64	0.2	0	1740
17	1518	1485	222	64	0.1	0	1444
17	1501	1470	240	64	0.2	0	1447
17	1504	1477	246	63	0.3	0	1442
17	1522	1488	238	64	0.3	0	1442
17	1462	1446	238	62	0.1	0	1277
17	1481	1466	240	62	0.3	0	1279
17	1478	1464	243	62	0.2	0	1285
17	1486	1464	242	61	0.2	0	1276
17	1464	1452	241	62	0.3	0	1283
17	1472	1458	241	61	0.5	0	1112
17	1471	1459	239	61	0.3	0	1112
17	1475	1461	241	61	0.3	0	1095
17	1461	1446	235	61	0.1	0	1121
18	1458	1417	242	68	0.2	0	1722
18	1457	1412	232	68	0.2	0	1726
18	1459	1416	229	67	0.2	0	1732
18	1468	1424	241	68	0.2	0	1728
18	1441	1404	242	66	0.3	0	1464
18	1441	1402	228	67	0.4	0	1465
18	1437	1397	239	66	0.3	0	1471
18	1408	1382	228	64	0.3	0	1310
18	1412	1386	244	64	0.3	0	1301
18	1409	1384	241	64	0.4	0	1305
18	1421	1395	245	64	0.4	0	1298

EGT = Exhaust gas temperature
Gr = Grains of moisture per pound of dry air

Table B-51. Detonation-Onset Engine Parameters, Part 51

Blend	Fuel Flow (lb/hr)	Brake Horsepower	Air-to-Fuel Ratio (average)	Equivalence Ratio	Brake-Specific Fuel Consumption (lb/hp hr)	Manifold Absolute Pressure (inHg)	Brake Mean Effective Pressure (psi)
18	99.7	180.1	11.65	1.231	0.554	24.59	112.1
18	99.1	180.0	11.70	1.220	0.551	24.60	111.9
18	101.4	179.2	11.55	1.242	0.564	24.60	111.6
18	130.8	235.5	11.46	1.251	0.555	27.83	132.5
18	100.9	180.1	11.58	1.238	0.560	24.59	112.1
19	161.1	270.2	10.73	1.313	0.596	29.59	146.4
19	161.2	267.5	10.70	1.320	0.603	29.60	145.7
19	139.0	233.5	10.82	1.301	0.595	27.62	131.4
19	138.4	232.8	10.85	1.298	0.594	27.59	131.0
19	138.8	232.7	10.82	1.302	0.596	27.59	131.0
19	119.3	207.6	11.23	1.254	0.575	26.27	124.0
19	119.2	207.3	11.19	1.258	0.575	26.27	123.8
19	120.8	207.1	11.00	1.281	0.583	26.23	123.7
19	120.8	207.4	11.03	1.277	0.582	26.27	123.9
19	119.0	208.2	11.21	1.257	0.572	26.26	124.3
19	119.2	208.0	11.10	1.260	0.573	26.25	123.7
19	120.6	206.9	11.01	1.279	0.583	26.28	123.5
19	104.4	179.5	11.21	1.257	0.581	24.44	111.8
19	103.4	179.2	11.30	1.250	0.577	24.45	111.6
19	105.4	179.1	11.12	1.266	0.589	24.46	111.5
19	104.4	179.7	11.24	1.253	0.581	24.43	111.9
19	102.9	178.5	11.35	1.241	0.577	24.46	111.1
19	104.7	178.8	11.10	1.268	0.585	24.43	111.3
19	104.0	178.1	11.08	1.271	0.584	24.25	110.9
19	140.2	232.6	10.74	1.311	0.603	27.60	130.9
19	160.6	268.8	10.72	1.313	0.597	29.59	145.7

Table B-52. Detonation-Onset Engine Parameters, Part 52

Blend	Engine Speed (rpm)	Engine Torque (ft-lb)	Fuel Flow (gal/hr)	Engine Inlet Air Temperature (°F)	Engine Inlet Air Pressure (inHg)	Test Cell Barometer (inHg)	Engine Cowling Temperature (°F)
18	2349	403	15.9	106	30.19	30.2	117
18	2349	402	15.8	105	30.2	30.2	117
18	2349	401	16.1	106	30.19	30.2	117
18	2599	476	20.8	107	30.22	30.21	115
18	2349	403	16.0	106	30.2	30.2	116
19	2699	525	26.7	103	30.09	30.09	115
19	2699	523	26.8	103	30.1	30.09	115
19	2599	472	23.2	104	30.1	30.09	116
19	2599	470	23.0	106	30.1	30.09	115
19	2599	470	23.1	106	30.09	30.09	116
19	2449	445	20.1	105	30.21	30.2	116
19	2449	446	19.9	104	30.2	30.2	115
19	2449	443	20.1	104	30.06	30.09	117
19	2449	445	20.1	105	30.09	30.09	116
19	2449	448	19.9	104	30.08	30.09	115
19	2449	444	19.9	105	30.06	30.09	117
19	2449	444	20.0	107	30.07	30.09	118
19	2349	401	17.5	105	30.19	30.2	116
19	2349	401	17.3	105	30.2	30.2	116
19	2349	400	17.7	104	30.2	30.2	117
19	2349	401	17.5	105	30.18	30.2	118
19	2349	399	17.2	105	30.2	30.2	117
19	2349	400	17.4	105	30.07	30.08	117
19	2349	398	17.3	105	30.07	30.09	116
19	2599	469	23.3	104	30.1	30.09	116
19	2699	525	26.7	103	30.08	30.09	115

Table B-53. Detonation-Onset Engine Parameters, Part 53

Blend	Fuel Temperature (°F)	Fuel Density (lb/gal)	Metered Fuel Pressure (psi)	Unmetered Fuel Pressure (psi)	CHT 1 (°F)	CHT 2 (°F)	CHT 3 (°F)
18	63	6.29	3.6	25.6	464	457	463
18	62	6.29	3.6	25.6	465	457	468
18	62	6.29	3.7	25.6	465	457	462
18	61	6.3	6.0	25.5	468	461	472
18	62	6.29	3.7	25.6	466	457	465
19	53	6.01	9.2	25.4	473	450	475
19	53	6.02	9.2	25.4	471	447	475
19	53	6.02	6.9	25.5	472	455	466
19	54	6.01	6.8	25.5	474	455	471
19	54	6.01	6.8	25.5	475	457	475
19	54	6.01	5.2	25.5	463	453	464
19	53	6.01	5.2	25.5	465	453	460
19	54	6.01	5.2	25.5	470	457	463
19	53	6.01	5.2	25.4	468	459	465
19	52	6.01	5.0	25.5	469	457	467
19	51	6.02	5.1	25.5	470	458	466
19	52	6.02	5.2	25.5	468	457	465
19	64	5.97	4.0	25.4	464	455	461
19	65	5.97	4.0	25.4	465	455	461
19	65	5.96	4.1	25.4	464	455	461
19	63	5.97	4.1	25.4	463	455	467
19	63	5.97	4.0	25.4	464	455	461
19	51	6.02	4.0	25.5	470	459	466
19	53	6.01	3.9	25.4	470	457	464
19	53	6.01	7.0	25.5	474	456	471
19	53	6.01	9.2	25.4	474	452	476

CHT = Cylinder head temperature

Table B-54. Detonation-Onset Engine Parameters, Part 54

Blend	CHT 4 (°F)	CHT 5 (°F)	CHT 6 (°F)	EGT 1 (°F)	EGT 2 (°F)	EGT 3 (°F)	EGT 4 (°F)
18	451	470	475	1369	1353	1417	1382
18	451	471	475	1373	1355	1420	1384
18	451	470	475	1362	1347	1412	1372
18	451	471	475	1402	1371	1458	1408
18	451	471	475	1363	1352	1413	1377
19	451	471	473	1409	1364	1459	1400
19	450	469	470	1405	1360	1458	1399
19	450	472	474	1374	1342	1431	1371
19	450	472	471	1378	1343	1432	1376
19	452	475	473	1373	1341	1431	1374
19	450	466	475	1355	1331	1404	1362
19	450	465	475	1355	1330	1405	1361
19	451	473	474	1346	1331	1407	1361
19	451	469	475	1346	1333	1403	1363
19	451	473	474	1359	1344	1418	1373
19	453	470	475	1356	1336	1414	1366
19	453	468	475	1350	1332	1404	1360
19	451	468	474	1342	1327	1396	1358
19	450	468	475	1350	1335	1404	1365
19	449	468	475	1337	1325	1395	1352
19	448	469	474	1340	1331	1394	1356
19	449	466	475	1354	1337	1406	1366
19	455	468	474	1346	1329	1397	1359
19	453	468	474	1348	1334	1401	1360
19	452	474	473	1371	1342	1429	1372
19	451	472	472	1408	1363	1458	1400

CHT = Cylinder head temperature
EGT = Exhaust gas temperature

Table B-55. Detonation-Onset Engine Parameters, Part 55

Blend	EGT 5 (°F)	EGT 6 (°F)	Oil Inlet Temperature (°F)	Oil Pressure (psi)	Engine Inlet Air Humidity Ratio (Gr/lb)	Engine Inlet Air Relative Humidity (%)	Engine Intake Airflow (lb/hr)
18	1403	1386	241	62	0.4	0	1135
18	1406	1389	232	62	0.3	0	1140
18	1397	1380	231	63	0.3	0	1131
18	1446	1402	242	67	0.4	0	1473
18	1401	1381	244	62	0.3	0	1137
19	1428	1399	241	68	0.8	0	1723
19	1425	1396	230	67	0.9	0	1719
19	1406	1377	240	66	0.5	0	1470
19	1412	1382	222	67	0.6	0	1455
19	1412	1378	231	67	0.7	0	1463
19	1389	1365	233	64	0.8	0	1297
19	1389	1367	241	62	0.7	0	1291
19	1381	1366	233	65	0.8	0	1288
19	1379	1366	239	65	0.8	0	1292
19	1387	1380	238	64	0.5	0	1288
19	1388	1373	232	64	0.4	0	1289
19	1382	1366	236	63	0.3	0	1286
19	1383	1359	236	63	0.7	0	1134
19	1385	1365	241	63	0.5	0	1131
19	1374	1357	224	63	0.6	0	1134
19	1380	1361	228	62	0.6	0	1134
19	1393	1370	244	62	0.3	0	1138
19	1374	1366	240	63	0.4	0	1117
19	1375	1369	243	62	0.6	0	1113
19	1404	1375	229	67	0.5	0	1466
19	1424	1399	235	68	0.8	0	1725

EGT = Exhaust gas temperature
Gr = Grains of moisture per pound of dry air

Table B-56. Detonation-Onset Engine Parameters, Part 56

Blend	Fuel Flow (lb/hr)	Brake Horsepower	Air-to-Fuel Ratio (average)	Equivalence Ratio	Brake-Specific Fuel Consumption (lb/hp hr)	Manifold Absolute Pressure (inHg)	Brake Mean Effective Pressure (psi)
20	131.0	269.1	12.93	1.058	0.487	29.63	145.8
20	133.1	267.0	12.73	1.075	0.499	29.61	144.7
20	112.0	232.9	13.00	1.050	0.481	27.59	131.2
20	116.8	233.8	12.54	1.091	0.500	27.59	131.6
20	114.7	233.8	12.71	1.076	0.490	27.58	131.6
20	112.1	232.5	13.01	1.052	0.482	27.59	130.8
20	101.4	207.3	12.75	1.073	0.489	26.29	123.8
20	98.2	206.1	13.07	1.047	0.476	26.36	123.1
20	99.5	207.6	12.93	1.058	0.479	26.37	124.0
20	98.6	206.6	13.04	1.049	0.477	26.35	123.4
20	86.9	178.1	12.98	1.054	0.488	24.52	110.9
20	87.9	179.6	12.88	1.062	0.489	24.54	111.9
20	86.3	178.5	13.12	1.043	0.483	24.55	111.2
20	83.8	177.1	13.29	1.029	0.473	24.56	110.3
20	130.8	269.6	12.83	1.067	0.485	29.61	146.1
20	129.7	267.7	12.82	1.067	0.484	29.61	145.1
21	No Detonation						
22	149.3	272.8	11.57	1.236	0.547	29.66	147.8
22	151.2	272.6	11.45	1.249	0.554	29.66	147.7
22	151.6	271.8	11.43	1.251	0.557	29.66	147.3
22	125.7	237.4	11.86	1.206	0.529	27.62	133.6
22	129.0	237.0	11.64	1.229	0.544	27.62	133.4
22	124.8	237.6	11.95	1.197	0.525	27.64	133.7
22	127.1	237.3	11.76	1.217	0.536	27.60	133.5
22	113.2	209.0	11.66	1.226	0.541	26.25	124.8
22	110.3	209.6	11.88	1.204	0.526	26.26	125.2
22	111.9	208.4	11.79	1.213	0.537	26.28	124.4
22	112.6	208.9	11.76	1.217	0.539	26.30	124.7
22	112.7	209.7	11.74	1.218	0.537	26.29	125.2
22	96.4	180.8	11.97	1.195	0.533	24.43	112.5
22	95.5	181.4	12.05	1.187	0.526	24.46	113.0
22	98.5	181.1	11.77	1.215	0.544	24.47	112.7

Table B-57. Detonation-Onset Engine Parameters, Part 57

Blend	Engine Speed (rpm)	Engine Torque (ft-lb)	Fuel Flow (gal/hr)	Engine Inlet Air Temperature (°F)	Engine Inlet Air Pressure (inHg)	Test Cell Barometer (inHg)	Engine Cowling Temperature (°F)
20	2699	525	20.5	103	30.11	30.09	115
20	2699	519	20.7	104	30.09	30.08	118
20	2599	471	17.6	103	30.09	30.08	117
20	2599	473	18.4	103	30.09	30.08	117
20	2598	473	17.9	104	30.08	30.08	116
20	2599	470	17.5	104	30.09	30.08	118
20	2449	445	15.8	105	30.08	30.08	118
20	2449	442	15.3	104	30.08	30.08	117
20	2449	445	15.7	105	30.08	30.08	116
20	2449	443	15.4	104	30.07	30.08	118
20	2349	398	13.6	104	30.07	30.08	117
20	2349	401	13.8	104	30.09	30.08	117
20	2349	400	13.6	105	30.08	30.07	119
20	2349	397	13.2	104	30.07	30.07	118
20	2699	525	20.4	104	30.09	30.08	116
20	2699	521	20.2	103	30.1	30.08	115
21	No Detonation						
22	2699	531	24.1	104	30.15	30.15	115
22	2699	530	24.4	104	30.15	30.14	115
22	2699	529	24.5	107	30.15	30.14	116
22	2599	480	20.3	105	30.14	30.13	117
22	2599	479	20.8	105	30.13	30.13	117
22	2599	480	20.1	104	30.15	30.13	116
22	2599	479	20.5	105	30.13	30.13	117
22	2450	448	18.2	104	30.11	30.13	118
22	2449	450	17.8	105	30.13	30.13	116
22	2450	447	18.1	106	30.14	30.13	116
22	2449	448	18.2	104	30.13	30.12	118
22	2449	450	18.2	105	30.12	30.12	117
22	2350	404	15.5	105	30.13	30.12	117
22	2349	406	15.4	105	30.12	30.12	117
22	2350	405	15.9	104	30.13	30.12	118

Table B-58. Detonation-Onset Engine Parameters, Part 58

Blend	Fuel Temperature (°F)	Fuel Density (lb/gal)	Metered Fuel Pressure (psi)	Unmetered Fuel Pressure (psi)	CHT 1 (°F)	CHT 2 (°F)	CHT 3 (°F)
20	53	6.42	5.7	25.9	470	453	478
20	55	6.41	5.8	26	477	461	473
20	53	6.42	4.3	25.9	476	463	475
20	55	6.41	4.7	25.9	475	461	470
20	55	6.41	4.5	26	473	456	461
20	54	6.41	4.3	26	477	462	466
20	54	6.41	3.6	25.9	471	459	469
20	55	6.41	3.3	25.9	473	462	464
20	54	6.41	3.5	25.9	470	458	468
20	54	6.41	3.4	25.9	472	462	463
20	54	6.41	2.6	25.9	466	455	462
20	55	6.41	2.8	25.9	471	462	467
20	55	6.41	2.7	25.9	474	464	465
20	54	6.41	2.6	25.9	472	464	466
20	55	6.41	5.7	25.9	475	459	475
20	56	6.41	5.7	26	475	459	479
21	No Detonation						
22	55	6.2	7.7	25.7	468	455	469
22	58	6.2	7.9	25.7	467	452	470
22	56	6.2	7.9	25.7	467	451	470
22	56	6.2	5.5	25.7	469	457	467
22	58	6.2	5.8	25.7	469	456	469
22	56	6.2	5.5	25.7	470	458	467
22	55	6.21	5.7	25.7	470	458	467
22	55	6.21	4.5	25.6	468	457	463
22	56	6.2	4.4	25.6	466	457	460
22	57	6.2	4.4	25.6	467	457	463
22	57	6.2	4.5	25.6	465	457	460
22	57	6.19	4.5	25.6	467	455	459
22	56	6.2	3.3	25.6	466	459	461
22	56	6.2	3.3	25.6	465	457	460
22	57	6.2	3.5	25.6	467	457	462

CHT = Cylinder head temperature

Table B-59. Detonation-Onset Engine Parameters, Part 59

Blend	CHT 4 (°F)	CHT 5 (°F)	CHT 6 (°F)	EGT 1 (°F)	EGT 2 (°F)	EGT 3 (°F)	EGT 4 (°F)
20	454	470	474	1597	1543	1643	1583
20	456	478	477	1582	1528	1633	1572
20	458	475	473	1552	1512	1605	1549
20	459	473	472	1524	1482	1573	1518
20	454	478	471	1534	1496	1591	1531
20	459	474	473	1555	1517	1610	1548
20	458	476	471	1495	1466	1542	1500
20	461	475	474	1526	1493	1572	1525
20	458	477	472	1505	1476	1551	1509
20	461	475	475	1514	1490	1566	1520
20	455	471	475	1493	1474	1543	1500
20	460	475	475	1488	1463	1534	1490
20	461	475	475	1497	1476	1548	1504
20	460	475	473	1521	1498	1564	1521
20	458	476	478	1594	1537	1641	1580
20	458	478	476	1590	1536	1640	1577
21	No Detonation						
22	455	468	479	1463	1414	1509	1452
22	455	466	479	1455	1403	1499	1441
22	454	465	476	1451	1398	1496	1437
22	457	468	475	1436	1403	1494	1436
22	457	468	475	1419	1387	1475	1419
22	459	470	477	1445	1410	1499	1444
22	459	469	478	1429	1396	1485	1429
22	460	469	475	1387	1368	1437	1396
22	459	468	476	1399	1381	1452	1410
22	459	469	475	1395	1375	1444	1402
22	458	468	475	1389	1376	1442	1402
22	458	467	475	1390	1372	1443	1400
22	459	466	475	1396	1378	1444	1403
22	461	466	475	1396	1380	1449	1409
22	460	466	475	1380	1366	1430	1393

CHT = Cylinder head temperature
EGT = Exhaust gas temperature

Table B-60. Detonation-Onset Engine Parameters, Part 60

Blend	EGT 5 (°F)	EGT 6 (°F)	Oil Inlet Temperature (°F)	Oil Pressure (psi)	Engine Inlet Air Humidity Ratio (Gr/lb)	Engine Inlet Air Relative Humidity (%)	Engine Intake Airflow (lb/hr)
20	1614	1581	242	68	0.8	0	1710
20	1607	1566	245	67	0.8	0	1721
20	1586	1552	226	66	0.6	0	1447
20	1557	1519	237	67	0.4	0	1449
20	1573	1535	223	67	0.5	0	1447
20	1594	1553	230	66	0.5	0	1452
20	1522	1510	228	64	0.5	0	1276
20	1554	1537	228	64	0.4	0	1278
20	1529	1518	226	65	0.9	0	1281
20	1547	1533	242	64	0.9	0	1287
20	1522	1511	242	63	0.5	0	1129
20	1514	1494	230	63	0.5	0	1112
20	1524	1510	244	62	0.6	0	1117
20	1540	1528	226	63	0.5	0	1121
20	1615	1580	244	67	0.7	0	1719
20	1613	1573	240	68	0.8	0	1705
21	No Detonation						
22	1484	1451	232	65	0.7	0	1723
22	1476	1439	246	65	0.6	0	1723
22	1475	1435	237	64	0.7	0	1722
22	1471	1445	225	64	0.6	0	1466
22	1457	1419	240	64	0.5	0	1470
22	1474	1450	243	64	0.5	0	1457
22	1460	1432	245	64	0.6	0	1465
22	1418	1404	237	62	0.6	0	1293
22	1430	1416	245	62	0.6	0	1295
22	1424	1410	243	62	0.5	0	1286
22	1420	1411	245	62	0.6	0	1296
22	1420	1407	241	62	0.6	0	1298
22	1425	1415	239	61	0.6	0	1126
22	1428	1418	243	61	0.5	0	1127
22	1410	1401	223	61	0.7	0	1133

EGT = Exhaust gas temperature
Gr = Grains of moisture per pound of dry air

Table B-61. Detonation-Onset Engine Parameters, Part 61

Blend	Fuel Flow (lb/hr)	Brake Horsepower	Air-to-Fuel Ratio (average)	Equivalence Ratio	Brake-Specific Fuel Consumption (lb/hp hr)	Manifold Absolute Pressure (inHg)	Brake Mean Effective Pressure (psi)
22	96.2	182.1	12.00	1.192	0.528	24.47	113.3
22	96.5	181.4	11.96	1.196	0.532	24.47	113.0
22	152.2	271.8	11.35	1.260	0.560	29.66	147.3
22	151.6	272.8	11.44	1.251	0.556	29.66	147.8
23	137.1	272.2	12.18	1.154	0.504	29.51	147.5
23	136.4	272.5	12.29	1.144	0.500	29.52	147.8
23	138.5	273.5	12.09	1.162	0.507	29.52	148.2
23	137.3	273.2	12.17	1.155	0.502	29.52	148.0
23	138.9	273.4	12.07	1.164	0.508	29.52	148.2
23	116.3	237.6	12.85	1.094	0.490	27.81	133.7
23	120.9	238.1	12.43	1.131	0.508	27.80	134.0
23	117.8	238.2	12.78	1.099	0.495	27.81	134.0
23	101.4	209.0	12.70	1.107	0.485	26.36	124.9
23	100.3	209.5	12.79	1.099	0.479	26.38	125.2
23	102.7	209.9	12.60	1.115	0.489	26.38	125.4
23	84.4	180.5	13.30	1.060	0.467	24.47	112.0
23	85.8	181.3	13.10	1.073	0.473	24.51	112.9
23	87.3	180.2	12.95	1.085	0.484	24.53	112.2
23	88.1	180.0	12.82	1.096	0.489	24.54	112.1
23	85.5	178.1	13.17	1.067	0.479	24.61	110.3
23	84.5	178.2	13.27	1.059	0.474	24.66	111.0
23	87.0	179.0	12.96	1.085	0.486	24.64	111.1
23	85.7	178.9	13.17	1.067	0.475	24.66	111.2
23	85.4	180.0	13.07	1.075	0.475	24.45	112.1
24	139.8	269.9	12.07	1.151	0.517	29.66	144.9
24	117.0	235.6	12.41	1.120	0.497	27.65	132.6
24	113.5	236.3	12.77	1.088	0.480	27.65	133.0
24	116.7	235.5	12.43	1.118	0.495	27.65	132.5

Table B-62. Detonation-Onset Engine Parameters, Part 62

Blend	Engine Speed (rpm)	Engine Torque (ft-lb)	Fuel Flow (gal/hr)	Engine Inlet Air Temperature (°F)	Engine Inlet Air Pressure (inHg)	Test Cell Barometer (inHg)	Engine Cowling Temperature (°F)
22	2349	405	15.6	104	30.13	30.12	116
22	2349	406	15.6	105	30.12	30.12	116
22	2699	529	24.5	103	30.15	30.14	115
22	2699	531	24.6	104	30.15	30.14	115
23	2700	530	22.3	103	30	29.98	115
23	2700	531	22.3	103	30	29.98	116
23	2700	532	22.5	102	30	29.98	115
23	2700	532	22.4	103	30.01	29.98	117
23	2700	532	23.0	103	30.01	29.98	118
23	2598	480	18.9	104	30.1	30.08	115
23	2599	481	19.6	104	30.08	30.08	116
23	2599	481	19.2	104	30.09	30.08	115
23	2448	448	16.6	106	30.04	30.05	116
23	2448	449	16.3	105	30.06	30.05	116
23	2449	450	16.7	104	30.06	30.05	117
23	2349	402	13.8	105	30.12	30.11	118
23	2349	405	14.0	105	30.14	30.12	116
23	2349	403	14.2	104	30.05	30.05	118
23	2349	403	14.3	105	30.04	30.05	117
23	2348	396	13.9	107	30.01	30.02	114
23	2349	398	13.7	106	30.02	30.02	116
23	2349	399	14.1	108	30.02	30.02	116
23	2349	399	14.0	104	30.02	30.02	117
23	2349	402	13.9	103	30.37	30.36	116
24	2699	520	22.0	105	30.14	30.12	116
24	2599	476	18.2	105	30.14	30.13	116
24	2599	477	17.6	105	30.15	30.13	114
24	2599	476	18.2	105	30.14	30.13	115

Table B-63. Detonation-Onset Engine Parameters, Part 63

Blend	Fuel Temperature (°F)	Fuel Density (lb/gal)	Metered Fuel Pressure (psi)	Unmetered Fuel Pressure (psi)	CHT 1 (°F)	CHT 2 (°F)	CHT 3 (°F)
22	58	6.2	3.4	25.6	465	455	459
22	57	6.2	3.4	25.6	465	457	459
22	56	6.2	8.1	25.6	467	452	473
22	57	6.2	8.0	25.7	468	452	468
23	55	6.14	6.7	25.7	477	458	473
23	55	6.15	6.6	25.7	478	461	474
23	56	6.14	6.8	25.7	477	458	474
23	57	6.14	6.7	25.8	476	458	477
23	58	6.14	6.9	25.7	476	459	476
23	54	6.15	4.7	25.7	475	461	472
23	52	6.16	5.1	25.8	475	462	472
23	55	6.15	4.8	25.8	475	458	468
23	56	6.14	3.8	25.7	471	457	468
23	55	6.14	3.7	25.7	474	461	465
23	54	6.15	3.8	25.7	469	457	463
23	56	6.14	2.7	25.7	466	460	461
23	55	6.14	2.8	25.7	468	459	460
23	56	6.14	2.8	25.7	472	460	467
23	55	6.14	2.9	25.7	470	459	466
23	53	6.15	2.7	25.7	469	459	466
23	53	6.15	2.6	25.7	471	461	471
23	54	6.15	2.8	25.7	469	459	470
23	55	6.14	2.7	25.7	471	460	472
23	52	6.16	2.8	25.7	471	455	473
24	54	6.43	6.7	25.9	463	455	478
24	53	6.43	4.8	25.8	472	468	473
24	54	6.43	4.5	25.8	471	470	469
24	55	6.43	4.8	25.8	468	469	467

CHT = Cylinder head temperature

Table B-64. Detonation-Onset Engine Parameters, Part 64

Blend	CHT 4 (°F)	CHT 5 (°F)	CHT 6 (°F)	EGT 1 (°F)	EGT 2 (°F)	EGT 3 (°F)	EGT 4 (°F)
22	462	465	475	1394	1378	1445	1406
22	463	466	475	1392	1379	1442	1403
22	455	467	478	1447	1399	1492	1433
22	455	466	478	1455	1408	1496	1442
23	459	478	467	1509	1460	1557	1501
23	462	474	468	1517	1465	1572	1512
23	460	472	467	1507	1457	1560	1501
23	460	474	467	1509	1461	1565	1508
23	460	472	467	1500	1450	1553	1492
23	458	472	472	1515	1474	1569	1508
23	460	474	475	1486	1449	1544	1482
23	456	474	472	1506	1469	1562	1503
23	459	476	471	1461	1434	1510	1465
23	463	475	475	1471	1445	1526	1476
23	458	475	472	1454	1433	1511	1464
23	463	469	475	1479	1459	1526	1490
23	466	469	475	1475	1456	1525	1481
23	460	474	475	1465	1435	1508	1468
23	460	473	475	1460	1434	1507	1463
23	457	477	474	1474	1456	1527	1481
23	462	472	475	1489	1466	1537	1496
23	460	470	474	1465	1441	1511	1469
23	461	472	475	1478	1460	1523	1487
23	461	475	472	1474	1450	1520	1481
24	456	471	454	1516	1474	1557	1512
24	466	475	460	1500	1474	1561	1503
24	466	476	460	1522	1493	1585	1524
24	465	476	459	1494	1475	1562	1505

CHT = Cylinder head temperature
EGT = Exhaust gas temperature

Table B-65. Detonation-Onset Engine Parameters, Part 65

Blend	EGT 5 (°F)	EGT 6 (°F)	Oil Inlet Temperature (°F)	Oil Pressure (psi)	Engine Inlet Air Humidity Ratio (Gr/lb)	Engine Inlet Air Relative Humidity (%)	Engine Intake Airflow (lb/hr)
22	1423	1415	246	61	0.6	0	1128
22	1418	1413	242	60	0.6	0	1128
22	1466	1434	231	65	0.6	0	1731
22	1479	1440	234	65	0.5	0	1727
23	1527	1492	246	65	0.4	0	1708
23	1544	1509	245	65	0.4	0	1698
23	1530	1495	232	64	0.5	0	1699
23	1534	1501	231	65	0.4	0	1699
23	1523	1486	228	65	0.5	0	1702
23	1551	1518	234	67	0.5	0	1461
23	1523	1491	231	67	0.7	0	1472
23	1538	1508	238	67	0.6	0	1463
23	1487	1477	245	63	0.4	0	1273
23	1498	1486	245	63	0.8	0	1284
23	1484	1473	244	63	0.5	0	1283
23	1508	1496	239	61	0.7	0	1122
23	1504	1487	223	62	0.6	0	1128
23	1491	1476	236	62	0.5	0	1121
23	1486	1471	233	62	0.6	0	1116
23	1506	1491	237	62	0.2	0	1119
23	1518	1501	236	62	0.1	0	1119
23	1494	1481	238	62	0.5	0	1119
23	1509	1494	243	62	0.4	0	1126
23	1502	1493	238	62	0.2	0	1094
24	1537	1519	223	65	0.3	0	1710
24	1537	1514	222	64	0.2	0	1439
24	1555	1532	232	64	0.2	0	1443
24	1541	1518	232	64	0.1	0	1439

EGT = Exhaust gas temperature
Gr = Grains of moisture per pound of dry air

Table B-66. Detonation-Onset Engine Parameters, Part 66

Blend	Fuel Flow (lb/hr)	Brake Horsepower	Air-to-Fuel Ratio (average)	Equivalence Ratio	Brake-Specific Fuel Consumption (lb/hp hr)	Manifold Absolute Pressure (inHg)	Brake Mean Effective Pressure (psi)
24	115.0	236.2	12.61	1.102	0.487	27.66	132.9
24	107.7	209.3	12.11	1.147	0.514	26.40	125.0
24	106.4	209.6	12.14	1.145	0.508	26.36	125.2
24	104.2	209.1	12.32	1.127	0.498	26.38	124.9
24	100.9	208.8	12.69	1.095	0.483	26.38	124.7
24	91.0	181.6	12.46	1.115	0.501	24.55	113.0
24	89.0	180.8	12.69	1.095	0.492	24.56	112.6
24	90.7	181.0	12.43	1.117	0.501	24.49	112.7
24	92.7	180.1	12.21	1.138	0.514	24.48	112.1
24	137.3	270.2	12.28	1.132	0.508	29.65	146.7
24	138.4	270.4	12.11	1.147	0.513	29.65	146.7
25	146.9	270.4	11.73	1.248	0.543	29.51	146.5
25	149.9	269.0	11.53	1.270	0.556	29.51	145.7
25	149.5	269.5	11.62	1.260	0.555	29.51	146.0
25	149.2	268.5	11.45	1.279	0.555	29.51	145.5
25	126.4	237.3	11.88	1.233	0.534	27.77	133.8
25	131.5	237.1	11.56	1.267	0.555	27.77	133.4
25	130.5	237.0	11.62	1.260	0.551	27.77	133.2
25	128.6	237.7	11.73	1.249	0.541	27.77	133.7
25	111.1	208.6	12.00	1.220	0.533	26.44	124.5
25	111.1	208.9	11.90	1.230	0.532	26.44	124.7
25	110.8	209.3	11.96	1.224	0.529	26.44	124.9
25	109.9	209.7	12.05	1.215	0.524	26.42	125.2
25	110.4	209.9	12.00	1.220	0.526	26.42	125.5
25	95.0	182.0	12.22	1.198	0.522	24.56	113.3
25	97.8	181.6	11.90	1.231	0.539	24.56	113.0
25	96.9	181.7	12.00	1.220	0.533	24.57	113.1
25	97.0	181.6	12.01	1.219	0.534	24.56	113.0
25	149.9	268.6	11.46	1.278	0.558	29.50	145.3

Table B-67. Detonation-Onset Engine Parameters, Part 67

Blend	Engine Speed (rpm)	Engine Torque (ft-lb)	Fuel Flow (gal/hr)	Engine Inlet Air Temperature (°F)	Engine Inlet Air Pressure (inHg)	Test Cell Barometer (inHg)	Engine Cowling Temperature (°F)
24	2599	479	18.2	102	30.14	30.13	115
24	2449	449	16.7	104	30.14	30.13	115
24	2449	449	16.5	105	30.13	30.13	114
24	2449	448	16.2	105	30.12	30.13	116
24	2449	448	15.7	105	30.13	30.13	114
24	2349	406	14.1	104	30.12	30.13	114
24	2349	404	13.8	104	30.12	30.13	115
24	2349	405	14.2	104	30.13	30.13	114
24	2349	403	14.4	105	30.12	30.13	114
24	2699	527	21.6	105	30.13	30.12	117
24	2699	528	21.3	105	30.13	30.12	116
25	2699	526	23.7	103	29.97	29.95	116
25	2700	524	24.2	104	29.98	29.95	118
25	2700	524	24.1	104	29.98	29.96	118
25	2699	523	24.0	103	29.97	29.95	117
25	2600	481	20.3	104	29.98	29.95	116
25	2600	479	21.1	103	29.98	29.95	116
25	2600	478	21.0	103	29.98	29.95	118
25	2600	480	20.7	104	29.97	29.95	117
25	2450	447	17.9	103	29.98	29.96	116
25	2450	448	18.1	104	29.98	29.96	117
25	2450	449	17.9	104	29.96	29.96	118
25	2450	450	17.8	104	29.96	29.96	117
25	2450	450	17.9	104	29.96	29.96	117
25	2350	406	15.3	104	29.96	29.96	117
25	2350	406	15.7	104	29.96	29.95	116
25	2350	406	15.6	104	29.96	29.96	118
25	2350	406	15.6	104	29.97	29.96	117
25	2699	523	24.5	104	29.97	29.95	116

Table B-68. Detonation-Onset Engine Parameters, Part 68

Blend	Fuel Temperature (°F)	Fuel Density (lb/gal)	Metered Fuel Pressure (psi)	Unmetered Fuel Pressure (psi)	CHT 1 (°F)	CHT 2 (°F)	CHT 3 (°F)
24	55	6.43	4.8	25.8	468	468	471
24	54	6.46	4.1	25.7	471	468	468
24	53	6.44	4.0	25.7	464	464	476
24	54	6.43	3.9	25.7	471	470	471
24	55	6.43	3.6	25.7	467	466	475
24	53	6.44	3.0	25.6	470	468	475
24	52	6.44	2.9	25.6	470	470	475
24	53	6.44	3.0	25.6	471	468	475
24	54	6.43	3.1	25.6	470	467	474
24	56	6.45	6.3	25.9	464	456	482
24	57	6.42	6.7	25.8	466	455	477
25	59	6.21	7.4	25.7	475	463	475
25	58	6.21	7.8	25.7	475	459	474
25	58	6.22	7.6	25.7	471	453	475
25	57	6.22	7.9	25.7	469	449	474
25	57	6.22	5.6	25.7	473	462	470
25	57	6.22	6.0	25.7	470	455	474
25	56	6.22	6.0	25.7	474	459	472
25	57	6.22	5.8	25.7	475	460	474
25	57	6.22	4.4	25.7	473	464	473
25	58	6.22	4.6	25.6	473	460	475
25	58	6.22	4.4	25.6	474	462	470
25	57	6.22	4.4	25.7	470	456	466
25	56	6.22	4.4	25.7	470	459	474
25	56	6.22	3.3	25.6	471	461	470
25	56	6.22	3.5	25.6	468	456	471
25	57	6.22	3.4	25.6	473	462	473
25	58	6.22	3.4	25.6	472	459	469
25	59	6.22	7.9	25.7	474	454	475

CHT = Cylinder head temperature

Table B-69. Detonation-Onset Engine Parameters, Part 69

Blend	CHT 4 (°F)	CHT 5 (°F)	CHT 6 (°F)	EGT 1 (°F)	EGT 2 (°F)	EGT 3 (°F)	EGT 4 (°F)
24	465	475	459	1501	1479	1566	1508
24	469	476	464	1438	1423	1500	1456
24	463	470	458	1447	1424	1491	1456
24	471	475	464	1450	1435	1515	1469
24	465	471	459	1473	1455	1525	1486
24	467	472	469	1452	1438	1487	1466
24	468	475	471	1463	1451	1507	1480
24	466	472	469	1449	1434	1495	1462
24	468	473	469	1436	1426	1486	1457
24	457	475	456	1529	1494	1588	1534
24	458	473	457	1511	1472	1566	1513
25	462	472	463	1448	1404	1500	1438
25	462	472	463	1431	1385	1477	1427
25	460	470	462	1437	1391	1492	1434
25	455	466	458	1425	1376	1472	1416
25	458	476	462	1405	1381	1469	1417
25	457	469	459	1388	1357	1445	1394
25	461	472	463	1396	1365	1453	1397
25	461	474	464	1405	1374	1461	1410
25	464	475	468	1375	1363	1435	1391
25	460	474	465	1368	1350	1427	1385
25	464	474	467	1376	1361	1432	1386
25	460	474	463	1378	1361	1435	1390
25	460	472	464	1377	1356	1432	1384
25	463	475	468	1381	1368	1438	1394
25	459	472	466	1363	1350	1421	1377
25	464	474	472	1370	1357	1423	1384
25	462	474	471	1367	1358	1423	1384
25	462	473	464	1420	1383	1482	1421

CHT = Cylinder head temperature
EGT = Exhaust gas temperature

Table B-70. Detonation-Onset Engine Parameters, Part 70

Blend	EGT 5 (°F)	EGT 6 (°F)	Oil Inlet Temperature (°F)	Oil Pressure (psi)	Engine Inlet Air Humidity Ratio (Gr/lb)	Engine Inlet Air Relative Humidity (%)	Engine Intake Airflow (lb/hr)
24	1537	1521	242	64	0.2	0	1453
24	1475	1465	231	61	0.2	0	1272
24	1483	1471	236	62	0.1	0	1271
24	1489	1475	239	62	0.1	0	1260
24	1508	1500	239	62	0.2	0	1266
24	1481	1471	227	61	0.2	0	1115
24	1493	1485	241	60	0.1	0	1112
24	1482	1471	236	60	0.2	0	1113
24	1466	1463	242	60	0.2	0	1103
24	1555	1538	245	65	0.3	0	1702
24	1539	1513	237	65	0.3	0	1702
25	1471	1432	236	65	0.5	0	1706
25	1450	1419	222	64	0.6	0	1710
25	1467	1424	244	65	0.6	0	1710
25	1451	1409	237	65	0.5	0	1713
25	1441	1412	228	64	0.5	0	1470
25	1423	1394	233	64	0.5	0	1475
25	1432	1400	238	64	0.6	0	1475
25	1435	1407	237	64	0.6	0	1464
25	1414	1395	238	62	0.5	0	1291
25	1405	1387	241	61	0.5	0	1291
25	1414	1395	229	62	0.6	0	1289
25	1407	1394	247	61	0.6	0	1293
25	1407	1391	240	62	0.5	0	1285
25	1415	1402	238	61	0.5	0	1119
25	1395	1387	242	60	0.6	0	1127
25	1403	1390	233	61	0.5	0	1131
25	1402	1389	245	60	0.6	0	1128
25	1450	1413	241	64	0.5	0	1703

EGT = Exhaust gas temperature
Gr = Grains of moisture per pound of dry air

Table B-71. Detonation-Onset Engine Parameters, Part 71

Blend	Fuel Flow (lb/hr)	Brake Horsepower	Air-to-Fuel Ratio (average)	Equivalence Ratio	Brake-Specific Fuel Consumption (lb/hp hr)	Manifold Absolute Pressure (inHg)	Brake Mean Effective Pressure (psi)
26	130.6	272.3	12.75	1.095	0.479	29.68	147.6
26	131.7	272.6	12.59	1.109	0.484	29.68	148.1
26	133.5	272.7	12.66	1.103	0.489	29.69	147.8
26	134.2	273.0	12.51	1.116	0.492	29.67	148.2
26	111.0	235.8	12.95	1.078	0.471	27.69	132.7
26	113.5	236.6	12.80	1.091	0.480	27.71	133.1
26	112.7	236.5	12.84	1.088	0.476	27.69	133.1
26	114.8	236.9	12.65	1.104	0.485	27.71	133.3
26	115.0	237.2	12.60	1.108	0.485	27.71	133.5
26	100.0	210.6	12.80	1.090	0.475	26.46	125.8
26	102.4	209.8	12.55	1.113	0.488	26.46	125.3
26	98.1	209.6	12.95	1.078	0.468	26.47	125.2
26	103.2	209.8	12.48	1.119	0.492	26.45	125.3
26	87.3	179.8	12.80	1.091	0.485	24.51	112.0
26	86.9	180.7	12.89	1.083	0.481	24.56	112.5
26	83.7	179.6	13.23	1.056	0.466	24.57	111.9
26	87.4	180.3	12.89	1.083	0.484	24.55	112.3
27	135.5	274.8	12.40	1.173	0.493	29.64	149.0
27	141.1	274.8	12.09	1.203	0.514	29.64	149.0
27	138.5	274.8	12.23	1.189	0.505	29.65	149.1
27	140.7	274.6	12.10	1.202	0.512	29.65	148.8
27	138.0	275.3	12.32	1.181	0.501	29.65	149.5
27	112.7	240.1	12.96	1.122	0.469	27.74	135.1
27	117.2	239.9	12.53	1.161	0.489	27.73	134.9
27	115.3	239.8	12.75	1.141	0.481	27.73	134.9
27	115.4	239.6	12.75	1.141	0.482	27.72	134.8
27	113.3	239.9	12.94	1.124	0.472	27.74	135.0
27	102.1	211.7	12.66	1.149	0.483	26.36	126.3
27	101.2	211.7	12.79	1.137	0.478	26.36	126.3

Table B-72. Detonation-Onset Engine Parameters, Part 72

Blend	Engine Speed (rpm)	Engine Torque (ft-lb)	Fuel Flow (gal/hr)	Engine Inlet Air Temperature (°F)	Engine Inlet Air Pressure (inHg)	Test Cell Barometer (inHg)	Engine Cowling Temperature (°F)
26	2699	530	20.5	105	30.14	30.13	115
26	2699	532	20.3	105	30.15	30.13	117
26	2699	531	20.8	105	30.15	30.13	117
26	2699	532	20.8	105	30.14	30.13	115
26	2599	476	17.2	105	30.13	30.13	116
26	2599	478	17.7	105	30.14	30.13	116
26	2599	479	17.8	106	30.13	30.13	115
26	2599	479	17.8	105	30.13	30.13	117
26	2599	479	17.9	105	30.14	30.13	115
26	2449	452	15.5	105	30.13	30.13	116
26	2449	449	15.9	105	30.13	30.13	116
26	2449	449	15.4	105	30.12	30.13	115
26	2449	450	16.0	105	30.12	30.13	117
26	2349	402	13.5	105	30.12	30.13	115
26	2349	404	13.6	105	30.14	30.13	117
26	2349	402	13.0	105	30.12	30.13	115
26	2349	403	13.6	105	30.11	30.13	115
27	2700	535	22.0	103	30.11	30.1	115
27	2699	535	22.7	103	30.12	30.11	116
27	2700	535	22.0	104	30.13	30.11	118
27	2699	534	22.9	103	30.12	30.11	115
27	2699	537	22.4	103	30.12	30.11	116
27	2600	485	18.0	103	30.13	30.1	114
27	2600	485	18.8	103	30.13	30.11	115
27	2599	485	18.5	103	30.12	30.1	117
27	2600	484	18.5	103	30.12	30.1	116
27	2599	484	18.3	104	30.13	30.11	118
27	2451	454	16.4	103	29.87	29.85	115
27	2451	454	16.2	104	29.87	29.85	116

Table B-73. Detonation-Onset Engine Parameters, Part 73

Blend	Fuel Temperature (°F)	Fuel Density (lb/gal)	Metered Fuel Pressure (psi)	Unmetered Fuel Pressure (psi)	CHT 1 (°F)	CHT 2 (°F)	CHT 3 (°F)
26	56	6.44	5.8	26	471	464	468
26	55	6.44	5.9	26	469	465	470
26	55	6.44	5.9	26	469	460	468
26	56	6.44	6.0	26	467	460	469
26	56	6.44	4.3	25.9	468	467	467
26	57	6.43	4.5	25.9	467	466	465
26	57	6.44	4.5	25.9	467	468	465
26	55	6.44	4.6	25.9	469	468	467
26	55	6.44	4.6	25.9	465	465	464
26	54	6.45	3.5	25.8	465	464	466
26	55	6.44	3.7	25.8	470	470	469
26	56	6.44	3.5	25.8	470	470	471
26	56	6.44	3.8	25.8	469	470	466
26	54	6.45	2.8	25.7	470	465	475
26	55	6.44	2.8	25.8	470	468	473
26	56	6.44	2.5	25.8	466	463	473
26	55	6.44	2.7	25.8	471	468	472
27	53	6.25	6.6	25.7	470	459	476
27	54	6.24	6.9	25.7	469	456	478
27	54	6.24	6.7	25.7	470	458	475
27	53	6.25	6.9	25.8	467	456	477
27	52	6.25	6.6	25.8	467	456	474
27	52	6.25	4.5	25.7	468	465	475
27	53	6.25	4.9	25.7	469	465	471
27	54	6.25	4.7	25.7	469	467	472
27	53	6.25	4.7	25.7	471	469	473
27	52	6.25	4.7	25.7	474	470	477
27	57	6.23	3.8	25.6	471	462	468
27	56	6.23	3.7	25.7	473	462	469

CHT = Cylinder head temperature

Table B-74. Detonation-Onset Engine Parameters, Part 74

Blend	CHT 4 (°F)	CHT 5 (°F)	CHT 6 (°F)	EGT 1 (°F)	EGT 2 (°F)	EGT 3 (°F)	EGT 4 (°F)
26	461	477	459	1567	1522	1628	1562
26	462	481	460	1558	1511	1612	1553
26	461	476	459	1560	1509	1614	1554
26	461	478	459	1547	1501	1604	1545
26	461	477	457	1534	1505	1595	1538
26	460	475	457	1515	1488	1579	1525
26	461	475	458	1507	1485	1573	1519
26	462	475	459	1512	1484	1569	1516
26	465	475	457	1507	1480	1569	1513
26	461	475	461	1481	1464	1539	1496
26	467	475	463	1466	1446	1523	1481
26	466	475	462	1491	1473	1546	1508
26	466	476	460	1463	1451	1525	1484
26	463	473	465	1470	1461	1512	1490
26	466	475	467	1468	1458	1504	1488
26	460	470	462	1496	1489	1549	1518
26	465	475	468	1471	1462	1519	1493
27	464	475	472	1494	1456	1549	1494
27	463	475	470	1483	1441	1532	1478
27	464	476	470	1492	1446	1543	1482
27	462	475	468	1483	1439	1531	1477
27	462	477	468	1496	1450	1547	1486
27	466	473	470	1496	1462	1542	1496
27	464	477	468	1472	1439	1522	1466
27	465	477	469	1482	1449	1537	1477
27	468	475	472	1482	1450	1542	1480
27	469	477	474	1493	1460	1548	1490
27	466	475	472	1436	1410	1488	1449
27	467	475	473	1444	1421	1501	1457

CHT = Cylinder head temperature
EGT = Exhaust gas temperature

Table B-75. Detonation-Onset Engine Parameters, Part 75

Blend	EGT 5 (°F)	EGT 6 (°F)	Oil Inlet Temperature (°F)	Oil Pressure (psi)	Engine Inlet Air Humidity Ratio (Gr/lb)	Engine Inlet Air Relative Humidity (%)	Engine Intake Airflow (lb/hr)
26	1591	1571	236	64	0.2	0	1695
26	1577	1553	228	65	0.2	0	1694
26	1581	1561	241	64	0.2	0	1693
26	1569	1549	227	65	0.2	0	1709
26	1569	1539	236	63	0.2	0	1449
26	1556	1532	238	64	0.2	0	1444
26	1551	1523	238	63	0.2	0	1440
26	1550	1523	227	63	0.2	0	1444
26	1544	1518	234	64	0.2	0	1441
26	1514	1492	234	62	0.2	0	1271
26	1496	1469	232	63	0.2	0	1281
26	1527	1491	232	62	0.2	0	1276
26	1502	1469	242	62	0.3	0	1272
26	1500	1492	240	61	0.1	0	1101
26	1493	1484	243	60	0.2	0	1105
26	1530	1521	236	61	0.2	0	1106
26	1503	1500	237	60	0.2	0	1101
27	1518	1485	239	64	0.3	0	1714
27	1502	1466	240	64	0.4	0	1697
27	1509	1477	242	63	0.4	0	1710
27	1503	1476	239	64	0.4	0	1707
27	1515	1484	242	64	0.4	0	1712
27	1529	1493	234	64	0.4	0	1456
27	1498	1464	241	63	0.4	0	1457
27	1512	1478	232	64	0.4	0	1454
27	1515	1488	243	63	0.3	0	1450
27	1526	1496	243	63	0.4	0	1450
27	1476	1442	237	62	0.5	0	1291
27	1482	1462	242	62	0.5	0	1278

EGT = Exhaust gas temperature
Gr = Grains of moisture per pound of dry air

Table B-76. Detonation-Onset Engine Parameters, Part 76

Blend	Fuel Flow (lb/hr)	Brake Horsepower	Air-to-Fuel Ratio (average)	Equivalence Ratio	Brake-Specific Fuel Consumption (lb/hp hr)	Manifold Absolute Pressure (inHg)	Brake Mean Effective Pressure (psi)
27	98.6	211.5	13.03	1.116	0.466	26.38	126.3
27	101.7	211.4	12.76	1.140	0.481	26.37	126.2
27	102.1	211.9	12.74	1.141	0.482	26.37	126.5
27	87.4	182.3	12.96	1.122	0.480	24.46	113.4
27	82.3	181.6	13.53	1.075	0.453	24.47	113.0
27	84.4	181.7	13.27	1.096	0.464	24.49	113.1
27	86.2	181.7	13.10	1.110	0.474	24.47	113.1
27	86.4	182.2	13.05	1.115	0.474	24.48	113.4
28	101.9	232.0	13.90	1.040	0.439	27.72	131.6
28	101.8	232.7	13.90	1.040	0.437	27.80	130.8
28	89.8	206.9	14.00	1.040	0.434	26.55	123.5
28	89.2	203.4	14.00	1.030	0.438	26.56	121.5
28	88.9	205.9	14.10	1.030	0.432	26.56	123.0
28	76.0	174.5	14.30	1.010	0.436	24.62	108.6
28	76.1	174.4	14.33	1.009	0.437	24.66	108.5
28	75.6	172.6	14.44	1.001	0.438	24.67	107.5
29	151.5	272.8	11.63	1.263	0.555	30.04	148.1
29	152.8	272.1	11.52	1.275	0.562	30.05	148.2
29	155.8	271.2	11.40	1.288	0.574	30.05	147.3
29	129.6	236.4	11.69	1.256	0.548	27.70	133.2
29	132.1	235.7	11.56	1.270	0.561	27.71	133.5
29	129.0	237.5	11.79	1.246	0.543	27.98	133.7
29	131.1	236.4	11.64	1.261	0.555	27.98	133.7
29	128.6	237.6	11.84	1.240	0.542	27.98	133.9
29	130.6	236.8	11.71	1.254	0.550	27.99	133.7
29	110.8	210.3	12.07	1.216	0.526	26.62	125.3
29	112.1	213.3	12.04	1.219	0.526	26.79	127.4
29	112.8	208.7	11.93	1.231	0.540	26.58	124.6

Table B-77. Detonation-Onset Engine Parameters, Part 77

Blend	Engine Speed (rpm)	Engine Torque (ft-lb)	Fuel Flow (gal/hr)	Engine Inlet Air Temperature (°F)	Engine Inlet Air Pressure (inHg)	Test Cell Barometer (inHg)	Engine Cowling Temperature (°F)
27	2450	454	16.0	103	29.87	29.85	117
27	2450	453	16.3	104	29.86	29.85	117
27	2450	454	16.4	103	29.86	29.85	116
27	2351	407	14.0	103	29.87	29.85	115
27	2350	405	13.4	104	29.87	29.85	115
27	2350	406	13.5	105	29.88	29.85	115
27	2350	406	13.8	104	29.86	29.85	116
27	2350	407	13.9	104	29.87	29.85	117
28	2599	472	16.3	105	30.17	30.16	113
28	2599	470	16.1	104	30.17	30.16	114
28	2449	444	14.1	105	30.15	30.13	115
28	2449	436	13.9	104	30.14	30.13	117
28	2449	442	13.9	105	30.13	30.13	117
28	2349	390	11.9	105	30.13	30.13	115
28	2350	390	11.9	105	30.14	30.13	116
28	2349	386	11.9	105	30.14	30.13	115
29	2699	532	24.7	102	30.53	30.51	115
29	2700	524	24.9	102	30.54	30.51	115
29	2699	529	25.3	102	30.54	30.51	116
29	2599	478	21.0	102	30.37	30.36	116
29	2599	479	21.4	101	30.38	30.36	116
29	2599	479	21.1	102	30.54	30.51	116
29	2599	478	21.3	102	30.53	30.51	115
29	2599	481	20.9	102	30.53	30.51	115
29	2599	479	21.3	102	30.53	30.51	117
29	2450	450	18.0	105	30.17	30.17	115
29	2449	458	18.2	103	30.38	30.36	115
29	2449	448	18.3	102	30.52	30.51	114

Table B-78. Detonation-Onset Engine Parameters, Part 78

Blend	Fuel Temperature (°F)	Fuel Density (lb/gal)	Metered Fuel Pressure (psi)	Unmetered Fuel Pressure (psi)	CHT 1 (°F)	CHT 2 (°F)	CHT 3 (°F)
27	55	6.23	3.7	25.7	471	462	471
27	55	6.23	3.8	25.7	474	463	472
27	56	6.23	3.8	25.7	474	464	472
27	56	6.23	2.9	25.6	470	468	474
27	55	6.23	2.7	25.6	471	465	473
27	55	6.24	2.7	25.6	471	463	470
27	55	6.23	2.8	25.6	474	464	469
27	57	6.23	2.8	25.6	472	464	470
28	52	6.39	3.9	25.8	469	466	471
28	54	6.39	3.8	25.8	471	469	467
28	53	6.39	3.0	25.8	466	466	463
28	55	6.41	3.0	25.8	470	469	465
28	54	6.38	2.9	25.8	470	469	465
28	53	6.39	2.2	25.7	469	467	466
28	54	6.38	2.2	25.7	470	468	467
28	54	6.38	2.2	25.7	471	467	467
29	54	6.16	7.8	25.5	468	464	474
29	53	6.16	8.0	25.5	468	463	477
29	52	6.17	8.2	25.5	465	458	474
29	53	6.16	6.0	25.5	459	456	475
29	52	6.17	6.1	25.5	459	458	482
29	53	6.17	5.9	25.5	469	468	468
29	52	6.17	5.9	25.5	466	463	465
29	53	6.17	5.7	25.5	467	465	468
29	54	6.19	5.9	25.5	468	468	469
29	52	6.17	4.4	25.6	469	465	471
29	52	6.17	4.5	25.5	464	464	465
29	54	6.16	4.5	25.4	464	462	462

CHT = Cylinder head temperature

Table B-79. Detonation-Onset Engine Parameters, Part 79

Blend	CHT 4 (°F)	CHT 5 (°F)	CHT 6 (°F)	EGT 1 (°F)	EGT 2 (°F)	EGT 3 (°F)	EGT 4 (°F)
27	467	476	472	1453	1429	1508	1463
27	468	475	474	1443	1420	1496	1458
27	470	475	475	1443	1420	1490	1452
27	462	474	471	1437	1416	1487	1446
27	464	475	473	1466	1451	1516	1482
27	464	475	472	1460	1443	1514	1478
27	466	475	473	1444	1430	1499	1464
27	466	475	473	1443	1427	1497	1460
28	471	475	461	1555	1522	1608	1552
28	474	476	463	1575	1538	1625	1567
28	471	475	460	1531	1509	1587	1545
28	476	476	462	1543	1519	1595	1554
28	476	475	461	1542	1515	1590	1553
28	471	475	467	1535	1527	1573	1554
28	472	475	468	1532	1531	1571	1557
28	471	475	468	1538	1536	1571	1564
29	459	475	465	1429	1390	1458	1430
29	460	477	467	1414	1388	1440	1427
29	455	471	462	1408	1377	1441	1413
29	457	469	463	1391	1368	1446	1402
29	458	470	473	1381	1357	1437	1390
29	466	475	469	1398	1379	1437	1408
29	460	473	464	1385	1368	1421	1396
29	461	474	466	1401	1381	1440	1415
29	462	476	466	1388	1369	1428	1403
29	469	475	466	1380	1361	1428	1389
29	467	473	469	1380	1367	1432	1399
29	464	474	466	1372	1362	1406	1393

CHT = Cylinder head temperature
EGT = Exhaust gas temperature

Table B-80. Detonation-Onset Engine Parameters, Part 80

Blend	EGT 5 (°F)	EGT 6 (°F)	Oil Inlet Temperature (°F)	Oil Pressure (psi)	Engine Inlet Air Humidity Ratio (Gr/lb)	Engine Inlet Air Relative Humidity (%)	Engine Intake Airflow (lb/hr)
27	1488	1469	243	62	0.6	0	1288
27	1479	1462	235	62	0.5	0	1282
27	1476	1459	229	62	0.5	0	1286
27	1464	1445	217	61	0.4	0	1120
27	1495	1475	219	61	0.5	0	1120
27	1489	1476	238	61	0.5	0	1118
27	1478	1455	241	61	0.6	0	1118
27	1474	1465	244	60	0.6	0	1125
28	1590	1561	232	63	0.1	0	1431
28	1606	1580	234	63	0.1	0	1447
28	1561	1543	222	62	0	0	1271
28	1573	1555	242	61	0.2	0	1276
28	1573	1556	236	61	0	0	1267
28	1562	1555	233	61	0.1	0	1106
28	1564	1556	222	60	0	0	1105
28	1565	1561	244	60	0.1	0	1111
29	1446	1434	220	65	0.4	0	1748
29	1436	1431	235	65	0.3	0	1745
29	1427	1419	242	65	0.3	0	1747
29	1421	1403	207	69	3.5	0	1467
29	1414	1394	192	69	0.7	0	1463
29	1427	1411	218	64	0.4	0	1472
29	1416	1401	239	63	0.3	0	1478
29	1431	1415	232	64	0.3	0	1480
29	1420	1407	241	63	0.2	0	1479
29	1408	1397	220	62	0	0	1291
29	1415	1396	212	67	8.8	0	1311
29	1399	1397	199	67	0.3	0	1298

EGT = Exhaust gas temperature
Gr = Grains of moisture per pound of dry air

Table B-81. Detonation-Onset Engine Parameters, Part 81

Blend	Fuel Flow (lb/hr)	Brake Horsepower	Air-to-Fuel Ratio (average)	Equivalence Ratio	Brake-Specific Fuel Consumption (lb/hp hr)	Manifold Absolute Pressure (inHg)	Brake Mean Effective Pressure (psi)
29	97.1	181.3	12.05	1.219	0.534	24.66	112.7
29	97.2	180.5	12.02	1.221	0.538	24.70	112.3
29	98.1	182.4	11.97	1.227	0.538	24.70	113.5
30	162.6	268.2	10.71	1.368	0.606	29.60	145.3
30	163.6	268.4	10.67	1.373	0.610	29.61	145.4
30	162.9	267.8	10.68	1.372	0.608	29.62	145.0
30	163.3	268.5	10.68	1.372	0.607	29.60	145.3
30	135.0	234.5	11.10	1.320	0.576	27.53	132.0
30	137.0	233.8	10.99	1.333	0.586	27.52	131.5
30	138.7	233.0	10.86	1.349	0.596	27.53	131.1
30	136.3	232.7	11.02	1.330	0.586	27.53	130.9
30	117.3	207.7	11.22	1.306	0.565	26.22	124.0
30	119.3	206.1	11.09	1.322	0.579	26.16	123.0
30	118.4	206.7	11.19	1.309	0.573	26.27	123.4
30	117.8	207.5	11.24	1.304	0.568	26.28	123.9
30	120.1	206.9	11.09	1.321	0.581	26.26	123.5
30	101.9	181.2	11.38	1.287	0.562	24.50	112.8
30	103.9	180.5	11.26	1.302	0.576	24.52	112.3
30	104.6	180.0	11.15	1.314	0.581	24.44	112.0
30	103.3	179.7	11.26	1.301	0.574	24.42	111.8
30	104.6	179.3	11.16	1.313	0.583	24.45	111.6
31	103.5	234.4	13.68	1.042	0.442	27.62	131.9
31	105.3	235.3	13.47	1.058	0.448	27.64	132.4
31	104.9	234.6	13.54	1.052	0.447	27.66	132.0
31	89.9	205.7	13.83	1.031	0.437	26.35	122.8
31	91.4	206.5	13.72	1.039	0.443	26.34	123.3
31	91.1	206.3	13.73	1.038	0.442	26.33	123.2

Table B-82. Detonation-Onset Engine Parameters, Part 82

Blend	Engine Speed (rpm)	Engine Torque (ft-lb)	Fuel Flow (gal/hr)	Engine Inlet Air Temperature (°F)	Engine Inlet Air Pressure (inHg)	Test Cell Barometer (inHg)	Engine Cowling Temperature (°F)
29	2350	405	15.8	104	30.17	30.17	117
29	2350	403	15.8	104	30.17	30.17	114
29	2350	407	16.0	104	30.16	30.17	116
30	2700	522	26.4	105	30.11	30.1	115
30	2700	521	26.7	104	30.11	30.1	116
30	2699	521	26.6	106	30.12	30.1	115
30	2700	522	26.5	104	30.11	30.1	114
30	2599	472	22.2	103	30.12	30.1	114
30	2600	472	22.2	104	30.11	30.1	114
30	2599	471	22.5	104	30.1	30.1	117
30	2599	470	22.1	105	30.1	30.1	116
30	2450	445	19.0	104	30.1	30.1	119
30	2450	442	19.3	104	30.09	30.1	116
30	2450	443	19.2	106	30.1	30.11	116
30	2450	445	19.1	105	30.11	30.11	117
30	2450	444	19.5	104	30.1	30.11	117
30	2350	405	16.5	104	30.1	30.11	117
30	2350	404	17.3	104	30.1	30.11	115
30	2350	402	16.9	103	30.1	30.1	116
30	2350	403	16.7	103	30.09	30.1	117
30	2350	401	17.0	104	30.11	30.1	118
31	2599	474	15.9	103	30.13	30.11	114
31	2599	476	16.1	105	30.13	30.1	117
31	2599	474	16.0	103	30.13	30.1	114
31	2450	441	13.8	104	30.12	30.11	116
31	2449	443	14.0	104	30.13	30.11	116
31	2449	442	13.9	103	30.11	30.11	115

Table B-83. Detonation-Onset Engine Parameters, Part 83

Blend	Fuel Temperature (°F)	Fuel Density (lb/gal)	Metered Fuel Pressure (psi)	Unmetered Fuel Pressure (psi)	CHT 1 (°F)	CHT 2 (°F)	CHT 3 (°F)
29	52	6.17	3.4	25.6	468	467	470
29	52	6.17	3.4	25.6	465	461	473
29	53	6.19	3.5	25.6	468	466	472
30	52	6.17	9.1	25.5	464	462	478
30	53	6.16	9.2	25.5	465	461	475
30	54	6.16	9.1	25.4	464	460	474
30	53	6.16	9.2	25.5	462	456	476
30	54	6.16	6.4	25.5	465	462	473
30	54	6.16	6.6	25.5	466	464	476
30	52	6.17	6.7	25.4	468	464	474
30	51	6.17	6.5	25.5	468	463	474
30	51	6.17	4.9	25.5	467	459	475
30	51	6.17	5.0	25.4	469	464	474
30	52	6.17	4.9	25.4	468	465	473
30	53	6.16	4.9	25.5	466	462	471
30	54	6.16	5.1	25.4	465	460	471
30	52	6.16	3.7	25.4	461	456	467
30	51	6.17	3.8	25.4	462	460	470
30	51	6.17	3.9	25.4	462	463	471
30	51	6.17	3.8	25.4	463	460	469
30	52	6.17	3.9	25.4	463	463	468
31	54	6.53	3.8	26	467	465	474
31	54	6.53	3.9	26	470	468	476
31	52	6.54	3.9	26	467	465	475
31	54	6.53	2.9	25.9	468	460	469
31	53	6.53	3.0	25.9	468	465	469
31	52	6.53	3.0	25.9	469	470	470

CHT = Cylinder head temperature

Table B-84. Detonation-Onset Engine Parameters, Part 84

Blend	CHT 4 (°F)	CHT 5 (°F)	CHT 6 (°F)	EGT 1 (°F)	EGT 2 (°F)	EGT 3 (°F)	EGT 4 (°F)
29	469	474	469	1369	1356	1422	1384
29	466	472	468	1366	1360	1421	1387
29	470	474	468	1367	1352	1416	1380
30	459	472	467	1377	1336	1431	1375
30	461	473	468	1377	1339	1432	1379
30	460	471	468	1378	1331	1430	1374
30	456	467	465	1372	1334	1428	1371
30	459	469	470	1366	1338	1418	1365
30	459	472	470	1357	1330	1414	1351
30	462	474	472	1352	1323	1409	1350
30	462	473	468	1364	1335	1421	1365
30	466	472	471	1338	1320	1398	1348
30	469	474	474	1332	1313	1394	1343
30	470	474	474	1338	1323	1395	1349
30	467	472	474	1335	1322	1400	1354
30	465	470	474	1330	1313	1384	1341
30	462	472	473	1342	1331	1396	1358
30	464	469	474	1325	1321	1382	1344
30	465	471	474	1322	1313	1381	1338
30	465	471	475	1333	1323	1391	1348
30	465	471	474	1331	1317	1387	1339
31	463	473	465	1579	1540	1629	1573
31	466	475	466	1565	1529	1619	1556
31	461	475	461	1567	1532	1622	1559
31	467	475	468	1542	1519	1594	1550
31	469	475	467	1536	1511	1591	1541
31	470	476	469	1535	1516	1594	1544

CHT = Cylinder head temperature
EGT = Exhaust gas temperature

Table B-85. Detonation-Onset Engine Parameters, Part 85

Blend	EGT 5 (°F)	EGT 6 (°F)	Oil Inlet Temperature (°F)	Oil Pressure (psi)	Engine Inlet Air Humidity Ratio (Gr/lb)	Engine Inlet Air Relative Humidity (%)	Engine Intake Airflow (lb/hr)
29	1400	1399	242	60	0	0	1124
29	1399	1390	235	60	0	0	1125
29	1391	1393	243	60	0	0	1121
30	1393	1364	234	64	0.2	0	1714
30	1398	1367	229	65	0.3	0	1705
30	1400	1367	239	64	0.3	0	1701
30	1395	1358	240	64	0.2	0	1720
30	1394	1367	243	63	0	0	1439
30	1386	1359	231	63	-0.1	0	1444
30	1379	1354	242	63	0.1	0	1446
30	1391	1360	224	64	0.1	0	1446
30	1370	1345	235	62	0.2	0	1272
30	1361	1343	231	61	0.1	0	1278
30	1367	1353	245	61	0.2	0	1276
30	1375	1359	218	61	0.2	0	1275
30	1361	1343	242	61	0.2	0	1265
30	1368	1358	223	61	0.3	0	1121
30	1359	1351	243	60	0.3	0	1117
30	1348	1345	240	60	0.2	0	1102
30	1359	1356	243	60	0.2	0	1118
30	1350	1344	234	60	0.3	0	1115
31	1607	1584	235	63	0.5	0	1440
31	1594	1571	240	63	0.3	0	1436
31	1597	1576	236	63	0.5	0	1446
31	1565	1562	244	61	0.3	0	1261
31	1564	1553	242	61	0.4	0	1270
31	1561	1556	237	62	0.4	0	1271

EGT = Exhaust gas temperature
Gr = Grains of moisture per pound of dry air

Table B-86. Detonation-Onset Engine Parameters, Part 86

Blend	Fuel Flow (lb/hr)	Brake Horsepower	Air-to-Fuel Ratio (average)	Equivalence Ratio	Brake-Specific Fuel Consumption (lb/hp hr)	Manifold Absolute Pressure (inHg)	Brake Mean Effective Pressure (psi)
31	89.3	205.7	13.83	1.031	0.434	26.33	122.8
31	76.1	173.1	14.19	1.004	0.440	24.35	107.7
31	76.9	175.8	14.00	1.018	0.438	24.55	109.4
31	77.2	175.5	13.97	1.020	0.440	24.54	109.3
32	160.7	271.0	10.83	1.331	0.593	29.64	147.0
32	157.9	272.3	10.99	1.313	0.580	29.67	147.5
32	158.6	271.8	10.93	1.319	0.584	29.66	147.3
32	134.2	235.9	11.17	1.292	0.569	27.50	132.7
32	134.0	235.9	11.16	1.292	0.570	27.51	132.9
32	132.5	235.6	11.28	1.279	0.562	27.50	132.5
32	117.2	209.1	11.32	1.274	0.561	26.28	124.8
32	113.9	209.6	11.54	1.250	0.544	26.27	125.1
32	115.8	210.1	11.42	1.263	0.551	26.24	125.5
32	99.5	182.0	11.62	1.241	0.548	24.49	113.3
32	99.8	180.7	11.55	1.248	0.552	24.38	112.5
32	100.6	180.3	11.48	1.257	0.557	24.36	112.2
33	150.0	275.1	11.30	1.251	0.546	29.67	149.0
33	152.7	273.7	11.11	1.272	0.557	29.68	148.2
33	151.8	274.3	11.21	1.260	0.554	29.69	149.0
33	126.3	238.3	11.56	1.223	0.530	27.48	134.0
33	129.1	237.2	11.33	1.248	0.543	27.47	133.2
33	125.3	237.7	11.60	1.218	0.527	27.48	133.7
33	112.2	209.3	11.54	1.225	0.536	26.17	124.9
33	108.6	209.4	11.82	1.195	0.519	26.16	125.0
33	110.0	209.1	11.70	1.208	0.526	26.14	124.8
33	94.8	180.7	11.84	1.194	0.525	24.27	112.4
33	95.2	180.5	11.83	1.195	0.527	24.29	112.4
33	94.1	180.8	11.92	1.185	0.518	24.25	112.4

Table B-87. Detonation-Onset Engine Parameters, Part 87

Blend	Engine Speed (rpm)	Engine Torque (ft-lb)	Fuel Flow (gal/hr)	Engine Inlet Air Temperature (°F)	Engine Inlet Air Pressure (inHg)	Test Cell Barometer (inHg)	Engine Cowling Temperature (°F)
31	2450	441	13.7	104	30.12	30.11	117
31	2350	387	11.7	104	30.11	30.11	115
31	2350	393	11.8	104	30.11	30.11	116
31	2350	392	11.8	103	30.11	30.11	116
32	2700	528	26.6	105	30.15	30.16	113
32	2700	530	26.2	105	30.17	30.16	115
32	2700	529	26.3	105	30.17	30.15	116
32	2600	476	22.2	105	30.17	30.16	116
32	2600	477	22.2	104	30.18	30.16	116
32	2600	476	22.0	105	30.17	30.16	115
32	2450	448	19.4	105	30.17	30.16	116
32	2450	449	18.9	104	30.16	30.16	114
32	2450	450	19.2	104	30.15	30.16	114
32	2350	407	16.5	106	30.16	30.16	113
32	2350	404	16.6	105	30.16	30.16	114
32	2350	403	16.7	105	30.15	30.16	115
33	2700	535	23.8	105	30.15	30.15	115
33	2699	532	24.5	106	30.16	30.15	115
33	2700	535	24.3	105	30.17	30.15	115
33	2600	481	20.1	105	30.16	30.15	115
33	2600	478	20.7	105	30.16	30.15	115
33	2600	480	20.0	105	30.16	30.15	117
33	2450	449	17.9	105	30.15	30.15	115
33	2450	449	17.3	105	30.15	30.15	116
33	2450	449	17.7	105	30.14	30.15	116
33	2350	403	15.3	105	30.15	30.15	116
33	2350	403	15.2	105	30.17	30.15	115
33	2350	403	15.0	105	30.14	30.15	115

Table B-88. Detonation-Onset Engine Parameters, Part 88

Blend	Fuel Temperature (°F)	Fuel Density (lb/gal)	Metered Fuel Pressure (psi)	Unmetered Fuel Pressure (psi)	CHT 1 (°F)	CHT 2 (°F)	CHT 3 (°F)
31	53	6.53	2.9	25.9	469	468	469
31	55	6.53	2.2	25.8	469	462	469
31	53	6.53	2.2	25.8	469	461	467
31	53	6.53	2.2	25.8	468	462	468
32	51	6.03	9.1	25.3	462	460	456
32	50	6.04	8.8	25.3	468	463	459
32	50	6.04	8.8	25.3	461	460	456
32	51	6.03	6.5	25.3	466	464	458
32	52	6.03	6.5	25.3	464	462	457
32	52	6.03	6.3	25.3	464	462	457
32	50	6.04	5.0	25.2	463	463	455
32	49	6.04	4.8	25.2	464	464	455
32	50	6.04	4.9	25.2	462	466	454
32	51	6.03	3.7	25.1	462	462	455
32	52	6.03	3.7	25.2	461	459	455
32	51	6.03	3.8	25.1	462	460	456
33	50	6.27	7.8	25.5	466	457	456
33	49	6.28	8.0	25.4	465	459	457
33	50	6.28	7.9	25.5	470	459	457
33	51	6.27	5.6	25.4	469	462	459
33	52	6.27	5.9	25.4	465	455	454
33	51	6.27	5.6	25.4	465	456	455
33	49	6.28	4.5	25.3	464	461	455
33	49	6.28	4.3	25.4	463	459	454
33	50	6.27	4.4	25.4	463	458	453
33	51	6.27	3.4	25.3	464	463	457
33	51	6.27	3.3	25.3	465	461	456
33	50	6.27	3.3	25.3	463	461	456

CHT = Cylinder head temperature

Table B-89. Detonation-Onset Engine Parameters, Part 89

Blend	CHT 4 (°F)	CHT 5 (°F)	CHT 6 (°F)	EGT 1 (°F)	EGT 2 (°F)	EGT 3 (°F)	EGT 4 (°F)
31	468	476	469	1535	1520	1593	1549
31	467	473	475	1540	1540	1583	1560
31	467	474	475	1542	1537	1583	1564
31	470	475	473	1536	1540	1583	1553
32	459	454	476	1388	1393	1416	1391
32	461	457	476	1400	1408	1434	1408
32	458	453	475	1388	1402	1427	1403
32	461	455	475	1372	1393	1411	1380
32	462	456	474	1372	1395	1412	1378
32	463	454	475	1381	1409	1421	1392
32	461	454	475	1351	1381	1388	1363
32	465	455	475	1360	1394	1397	1379
32	462	453	475	1349	1386	1390	1369
32	462	456	475	1353	1393	1389	1375
32	461	455	475	1349	1388	1384	1373
32	462	456	475	1348	1384	1384	1371
33	461	454	478	1447	1457	1484	1456
33	463	455	476	1436	1447	1470	1444
33	460	456	477	1443	1450	1476	1449
33	466	458	475	1425	1446	1465	1432
33	462	453	476	1414	1436	1453	1426
33	460	452	477	1429	1451	1467	1438
33	463	456	476	1395	1425	1430	1410
33	463	454	476	1404	1437	1443	1422
33	463	453	475	1398	1424	1437	1411
33	463	457	475	1392	1426	1424	1413
33	463	457	475	1397	1435	1434	1422
33	463	459	475	1399	1438	1436	1424

CHT = Cylinder head temperature
EGT = Exhaust gas temperature

Table B-90. Detonation-Onset Engine Parameters, Part 90

Blend	EGT 5 (°F)	EGT 6 (°F)	Oil Inlet Temperature (°F)	Oil Pressure (psi)	Engine Inlet Air Humidity Ratio (Gr/lb)	Engine Inlet Air Relative Humidity (%)	Engine Intake Airflow (lb/hr)
31	1569	1562	223	61	0.4	0	1269
31	1564	1556	228	61	0.4	0	1100
31	1565	1561	224	60	0.4	0	1108
31	1558	1560	245	60	0.3	0	1106
32	1403	1400	245	66	0.3	0	1738
32	1419	1416	231	66	0.3	0	1731
32	1421	1412	231	66	0.3	0	1722
32	1400	1395	245	65	0.3	0	1466
32	1400	1397	223	65	0.2	0	1470
32	1406	1405	220	65	0.4	0	1462
32	1380	1386	242	63	0.2	0	1297
32	1392	1396	240	63	0.3	0	1295
32	1382	1385	245	63	0.2	0	1293
32	1379	1392	243	62	0.1	0	1132
32	1374	1389	245	62	0.2	0	1131
32	1368	1384	244	62	0.3	0	1118
33	1477	1463	219	66	0.2	0	1725
33	1468	1452	226	66	0.4	0	1728
33	1468	1458	220	66	0.3	0	1725
33	1456	1455	225	64	0.4	0	1455
33	1443	1439	223	65	0.3	0	1460
33	1458	1455	227	64	0.3	0	1457
33	1425	1426	243	63	0.4	0	1286
33	1432	1437	230	64	0.3	0	1279
33	1428	1431	241	63	0.3	0	1279
33	1413	1425	221	62	0.3	0	1126
33	1421	1434	243	62	0.4	0	1120
33	1422	1436	238	62	0.3	0	1122

EGT = Exhaust gas temperature
Gr = Grains of moisture per pound of dry air

Table B-91. Detonation-Onset Engine Parameters, Part 91

Blend	Fuel Flow (lb/hr)	Brake Horsepower	Air-to-Fuel Ratio (average)	Equivalence Ratio	Brake-Specific Fuel Consumption (lb/hp hr)	Manifold Absolute Pressure (inHg)	Brake Mean Effective Pressure (psi)
34	159.1	269.2	10.59	1.299	0.591	29.55	145.8
34	158.8	268.6	10.58	1.300	0.591	29.57	145.4
34	156.7	269.1	10.69	1.287	0.582	29.57	145.7
34	139.4	234.1	10.65	1.292	0.597	27.54	131.7
34	137.4	233.8	10.76	1.278	0.588	27.56	131.2
34	138.7	233.9	10.69	1.287	0.591	27.54	131.2
34	119.0	208.4	10.93	1.259	0.571	26.28	124.4
34	119.0	208.0	10.98	1.252	0.572	26.30	124.1
34	119.1	208.1	10.96	1.255	0.572	26.28	124.2
34	102.0	179.5	11.11	1.238	0.570	24.33	111.7
34	102.1	179.1	11.11	1.238	0.570	24.32	111.5
34	103.3	179.1	11.03	1.247	0.579	24.33	111.5
35	129.4	271.3	12.68	1.142	0.477	29.59	146.9
35	130.9	271.0	12.59	1.151	0.484	29.59	147.0
35	127.5	270.4	13.03	1.112	0.472	29.60	146.6
35	109.6	237.4	13.12	1.104	0.463	27.81	133.7
35	107.1	236.5	13.38	1.082	0.453	27.82	133.0
35	108.0	236.8	13.37	1.083	0.456	27.83	133.1
35	96.5	210.4	13.16	1.101	0.459	26.54	125.6
35	92.1	208.4	13.75	1.053	0.442	26.54	124.3
35	98.1	211.1	13.04	1.110	0.465	26.53	126.0
35	82.9	180.5	13.46	1.076	0.459	24.52	112.3
35	83.9	180.3	13.35	1.085	0.465	24.51	112.1
35	81.9	180.1	13.64	1.062	0.455	24.51	112.0
36	135.0	272.8	12.71	1.144	0.495	29.66	147.8
36	133.5	274.1	12.78	1.138	0.488	29.67	148.7
36	136.2	273.0	12.57	1.157	0.497	29.67	148.8
36	135.8	274.9	12.63	1.151	0.493	29.65	149.3

Table B-92. Detonation-Onset Engine Parameters, Part 92

Blend	Engine Speed (rpm)	Engine Torque (ft-lb)	Fuel Flow (gal/hr)	Engine Inlet Air Temperature (°F)	Engine Inlet Air Pressure (inHg)	Test Cell Barometer (inHg)	Engine Cowling Temperature (°F)
34	2700	524	24.9	105	30.05	30.04	114
34	2701	522	24.8	106	30.06	30.04	115
34	2701	523	24.5	105	30.06	30.04	117
34	2600	473	21.8	105	30.06	30.05	114
34	2600	471	21.5	106	30.06	30.04	116
34	2600	471	21.8	105	30.05	30.05	116
34	2450	445	18.7	106	30.05	30.04	116
34	2451	446	18.6	105	30.06	30.05	115
34	2451	446	18.6	105	30.06	30.04	115
34	2350	401	15.9	103	30.05	30.05	113
34	2350	400	16.0	104	30.05	30.05	114
34	2351	399	16.3	104	30.05	30.05	114
35	2701	528	20.8	105	30.05	30.04	116
35	2701	528	21.4	105	30.06	30.04	115
35	2701	528	20.6	105	30.06	30.04	116
35	2601	481	18.0	105	30.06	30.04	116
35	2600	478	17.3	104	30.05	30.04	115
35	2601	478	17.3	106	30.04	30.04	116
35	2451	451	15.5	105	30.04	30.04	116
35	2451	447	14.8	104	30.05	30.04	115
35	2451	452	15.7	104	30.04	30.04	116
35	2351	403	13.3	104	30.05	30.04	115
35	2351	403	13.4	104	30.04	30.04	116
35	2351	402	13.1	105	30.03	30.04	116
36	2699	531	21.5	103	30.12	30.12	115
36	2699	533	21.5	104	30.13	30.12	117
36	2699	532	21.9	103	30.13	30.12	117
36	2699	536	21.7	103	30.12	30.12	105

Table B-93. Detonation-Onset Engine Parameters, Part 93

Blend	Fuel Temperature (°F)	Fuel Density (lb/gal)	Metered Fuel Pressure (psi)	Unmetered Fuel Pressure (psi)	CHT 1 (°F)	CHT 2 (°F)	CHT 3 (°F)
34	55	6.4	8.6	25.3	475	459	468
34	54	6.4	8.6	25.3	475	460	470
34	54	6.4	8.4	25.3	482	465	473
34	56	6.4	6.6	25.3	472	461	465
34	57	6.39	6.4	25.3	474	462	467
34	56	6.39	6.6	25.3	476	461	467
34	54	6.4	5.0	25.1	469	456	460
34	54	6.4	4.9	25.1	470	457	463
34	54	6.4	5.0	25.1	471	457	464
34	56	6.39	3.8	25.1	466	454	462
34	56	6.39	3.8	25.1	468	454	460
34	55	6.39	3.9	25.1	468	453	461
35	56	6.23	6.2	25.6	477	459	466
35	55	6.24	6.3	25.7	476	459	465
35	56	6.23	5.9	25.7	475	457	467
35	56	6.23	4.7	25.7	476	462	467
35	58	6.23	4.5	25.6	480	461	465
35	57	6.23	4.4	25.7	478	459	463
35	57	6.23	3.7	25.5	472	458	459
35	57	6.23	3.4	25.5	473	457	458
35	56	6.24	3.7	25.5	471	458	460
35	56	6.23	2.8	25.4	469	459	461
35	55	6.24	2.8	25.4	469	458	461
35	55	6.24	2.7	25.4	468	457	460
36	54	6.27	6.1	26	467	460	478
36	53	6.25	6.2	26	463	450	480
36	52	6.25	6.4	26	462	450	483
36	53	6.25	6.2	26	450	436	478

CHT = Cylinder head temperature

Table B-94. Detonation-Onset Engine Parameters, Part 94

Blend	CHT 4 (°F)	CHT 5 (°F)	CHT 6 (°F)	EGT 1 (°F)	EGT 2 (°F)	EGT 3 (°F)	EGT 4 (°F)
34	470	465	471	1418	1405	1455	1433
34	472	467	473	1423	1405	1457	1429
34	476	470	476	1440	1409	1470	1442
34	471	468	474	1387	1379	1426	1402
34	472	466	473	1399	1392	1438	1412
34	470	465	471	1399	1388	1433	1404
34	470	462	475	1366	1369	1407	1388
34	469	462	475	1381	1379	1415	1397
34	469	462	475	1377	1376	1412	1394
34	473	464	475	1371	1379	1411	1397
34	473	462	475	1374	1380	1412	1399
34	473	463	475	1363	1369	1400	1389
35	473	466	473	1532	1506	1566	1531
35	471	465	471	1508	1494	1555	1524
35	474	467	471	1531	1523	1582	1546
35	476	466	475	1507	1501	1552	1518
35	473	465	472	1532	1524	1579	1543
35	470	462	470	1533	1523	1574	1539
35	474	462	476	1474	1477	1514	1493
35	476	460	474	1515	1519	1554	1532
35	475	462	475	1470	1471	1507	1486
35	469	465	475	1476	1487	1514	1497
35	473	464	476	1475	1488	1514	1500
35	476	467	474	1483	1501	1523	1515
36	457	472	460	1522	1480	1576	1519
36	455	469	458	1523	1478	1570	1516
36	452	467	454	1500	1466	1553	1502
36	440	457	447	1516	1472	1564	1513

CHT = Cylinder head temperature
EGT = Exhaust gas temperature

Table B-95. Detonation-Onset Engine Parameters, Part 95

Blend	EGT 5 (°F)	EGT 6 (°F)	Oil Inlet Temperature (°F)	Oil Pressure (psi)	Engine Inlet Air Humidity Ratio (Gr/lb)	Engine Inlet Air Relative Humidity (%)	Engine Intake Airflow (lb/hr)
34	1449	1445	236	66	0.6	0	1708
34	1453	1441	244	66	0.5	0	1704
34	1465	1451	245	66	0.5	0	1698
34	1422	1417	228	66	0.4	0	1446
34	1433	1424	238	65	0.5	0	1449
34	1432	1418	233	65	0.5	0	1446
34	1399	1403	232	63	0.6	0	1276
34	1413	1411	239	64	0.4	0	1276
34	1407	1410	243	63	0.5	0	1279
34	1403	1408	235	62	0.5	0	1115
34	1404	1408	242	62	0.6	0	1113
34	1389	1399	243	62	0.5	0	1110
35	1558	1540	231	65	0.5	0	1695
35	1547	1534	220	66	0.5	0	1697
35	1573	1558	230	66	0.6	0	1696
35	1549	1536	244	65	0.5	0	1460
35	1574	1559	234	65	0.6	0	1463
35	1570	1556	222	65	0.6	0	1461
35	1514	1512	235	64	0.6	0	1289
35	1551	1546	229	63	0.5	0	1289
35	1505	1506	221	64	0.5	0	1283
35	1503	1509	217	62	0.5	0	1110
35	1508	1508	243	62	0.5	0	1118
35	1507	1517	214	62	0.5	0	1115
36	1540	1523	244	64	0.4	0	1707
36	1537	1509	224	65	0.4	0	1701
36	1524	1508	227	65	0.5	0	1712
36	1532	1501	236	65	0.5	0	1720

EGT = Exhaust gas temperature
Gr = Grains of moisture per pound of dry air

Table B-96. Detonation-Onset Engine Parameters, Part 96

Blend	Fuel Flow (lb/hr)	Brake Horsepower	Air-to-Fuel Ratio (average)	Equivalence Ratio	Brake-Specific Fuel Consumption (lb/hp hr)	Manifold Absolute Pressure (inHg)	Brake Mean Effective Pressure (psi)
36	134.0	274.7	12.75	1.141	0.488	29.66	148.9
36	116.3	239.5	12.63	1.151	0.486	27.79	134.8
36	114.0	238.8	12.90	1.128	0.478	27.70	134.4
36	113.9	238.0	12.82	1.135	0.478	27.68	134.0
36	116.6	238.6	12.63	1.152	0.489	27.69	134.2
36	100.8	210.7	12.89	1.128	0.478	26.29	125.8
36	102.8	210.8	12.62	1.153	0.488	26.30	125.9
36	99.2	209.2	12.98	1.121	0.474	26.27	124.9
36	100.5	211.3	12.89	1.128	0.476	26.33	126.2
36	98.2	210.7	13.09	1.111	0.466	26.37	125.8
36	85.0	181.7	13.28	1.095	0.468	24.51	113.1
36	87.8	182.6	12.93	1.125	0.481	24.54	113.7
36	86.6	182.7	13.13	1.107	0.474	24.55	113.8
36	83.0	181.7	13.54	1.074	0.457	24.55	113.1
37	130.5	274.6	13.04	1.107	0.475	30.05	149.1
37	131.7	274.8	13.00	1.110	0.479	30.05	149.2
37	131.3	275.1	13.00	1.110	0.478	30.05	150.1
37	112.1	235.2	13.04	1.107	0.477	27.86	132.3
37	107.5	235.5	13.44	1.074	0.456	27.86	132.5
37	111.5	237.1	13.11	1.101	0.470	27.87	133.4
37	94.2	209.6	13.57	1.064	0.450	26.64	125.1
37	95.6	209.1	13.44	1.074	0.457	26.63	124.9
37	98.4	210.2	13.16	1.097	0.468	26.63	125.5
37	95.1	209.9	13.49	1.070	0.453	26.63	125.3
37	85.3	182.2	13.38	1.078	0.468	24.86	113.4
37	83.1	180.6	13.52	1.067	0.460	24.76	112.4
37	84.3	180.6	13.43	1.075	0.467	24.76	112.4

Table B-97. Detonation-Onset Engine Parameters, Part 97

Blend	Engine Speed (rpm)	Engine Torque (ft-lb)	Fuel Flow (gal/hr)	Engine Inlet Air Temperature (°F)	Engine Inlet Air Pressure (inHg)	Test Cell Barometer (inHg)	Engine Cowling Temperature (°F)
36	2699	535	21.7	105	30.12	30.12	100
36	2599	484	18.6	104	30.13	30.11	115
36	2599	483	18.3	103	30.13	30.12	117
36	2599	481	18.5	103	30.12	30.12	115
36	2599	482	18.7	104	30.12	30.12	117
36	2449	452	16.1	103	30.12	30.12	117
36	2449	452	16.5	103	30.12	30.12	117
36	2449	449	15.9	105	30.12	30.12	115
36	2449	452	16.1	103	30.11	30.12	117
36	2449	452	15.8	104	30.12	30.11	116
36	2349	407	13.7	104	30.1	30.12	116
36	2349	408	14.1	103	30.12	30.11	116
36	2349	409	13.9	104	30.12	30.12	117
36	2349	406	13.4	103	30.11	30.12	116
37	2699	535	20.5	103	30.52	30.5	116
37	2700	536	20.8	103	30.53	30.5	115
37	2699	539	20.2	103	30.53	30.5	115
37	2600	480	17.9	103	30.52	30.5	114
37	2599	476	16.8	102	30.52	30.5	116
37	2599	478	17.7	102	30.51	30.5	116
37	2450	449	14.8	102	30.52	30.5	115
37	2450	448	15.0	102	30.52	30.5	116
37	2450	452	15.6	102	30.52	30.5	115
37	2450	450	14.9	102	30.52	30.5	116
37	2349	407	13.4	102	30.51	30.5	115
37	2350	404	13.0	102	30.52	30.5	117
37	2350	404	13.2	102	30.51	30.5	115

Table B-98. Detonation-Onset Engine Parameters, Part 98

Blend	Fuel Temperature (°F)	Fuel Density (lb/gal)	Metered Fuel Pressure (psi)	Unmetered Fuel Pressure (psi)	CHT 1 (°F)	CHT 2 (°F)	CHT 3 (°F)
36	54	6.24	6.2	26	455	438	478
36	54	6.24	4.8	25.9	466	463	478
36	52	6.25	4.5	25.9	468	464	475
36	51	6.25	4.7	25.9	470	466	475
36	53	6.25	4.8	25.9	471	466	475
36	53	6.25	3.6	25.8	469	467	474
36	53	6.25	3.7	25.8	467	464	475
36	51	6.25	3.6	25.8	468	466	475
36	52	6.25	3.6	25.8	464	461	474
36	53	6.25	3.5	25.8	463	463	475
36	53	6.25	2.7	25.8	467	460	475
36	52	6.25	2.8	25.8	468	462	475
36	52	6.25	2.7	25.8	469	466	470
36	53	6.25	2.6	25.8	469	468	471
37	54	6.38	5.6	25.9	469	466	476
37	53	6.38	5.7	25.9	469	466	477
37	53	6.38	5.8	25.9	469	467	481
37	53	6.38	4.5	25.8	468	464	475
37	53	6.38	4.1	25.9	469	468	475
37	54	6.38	4.4	25.8	472	469	477
37	52	6.38	3.2	25.7	470	467	465
37	52	6.38	3.3	25.7	470	466	465
37	53	6.38	3.5	25.7	473	469	467
37	54	6.38	3.2	25.8	469	466	463
37	52	6.38	2.6	25.6	472	467	468
37	54	6.38	2.6	25.6	472	467	473
37	54	6.38	2.6	25.6	473	466	471

CHT = Cylinder head temperature

Table B-99. Detonation-Onset Engine Parameters, Part 99

Blend	CHT 4 (°F)	CHT 5 (°F)	CHT 6 (°F)	EGT 1 (°F)	EGT 2 (°F)	EGT 3 (°F)	EGT 4 (°F)
36	443	459	446	1523	1478	1564	1511
36	461	471	462	1472	1442	1531	1472
36	461	471	460	1491	1460	1550	1490
36	465	473	462	1482	1449	1541	1481
36	462	473	463	1474	1445	1533	1476
36	466	475	468	1444	1427	1503	1460
36	466	474	470	1437	1417	1493	1446
36	466	475	466	1450	1436	1511	1467
36	461	470	465	1447	1426	1501	1457
36	462	471	465	1457	1436	1509	1469
36	465	473	472	1452	1441	1504	1466
36	467	473	472	1437	1428	1495	1456
36	469	475	474	1448	1440	1502	1466
36	469	475	474	1466	1455	1519	1483
37	463	477	472	1555	1517	1589	1553
37	463	477	471	1543	1510	1572	1547
37	464	477	472	1547	1507	1578	1548
37	463	474	466	1495	1475	1533	1509
37	465	472	467	1533	1513	1570	1540
37	466	473	468	1499	1479	1530	1508
37	470	476	470	1502	1487	1537	1517
37	470	475	466	1492	1481	1533	1510
37	471	475	468	1462	1455	1502	1482
37	469	474	466	1491	1479	1529	1508
37	470	475	469	1470	1466	1513	1492
37	472	475	470	1484	1481	1519	1505
37	471	474	469	1472	1472	1515	1497

CHT = Cylinder head temperature
EGT = Exhaust gas temperature

Table B-100. Detonation-Onset Engine Parameters, Part 100

Blend	EGT 5 (°F)	EGT 6 (°F)	Oil Inlet Temperature (°F)	Oil Pressure (psi)	Engine Inlet Air Humidity Ratio (Gr/lb)	Engine Inlet Air Relative Humidity (%)	Engine Intake Airflow (lb/hr)
36	1539	1512	239	64	0.4	0	1705
36	1501	1479	241	63	0.4	0	1458
36	1521	1489	226	63	0.4	0	1458
36	1512	1490	240	63	0.4	0	1441
36	1507	1486	241	63	0.3	0	1449
36	1480	1468	244	61	0.4	0	1274
36	1463	1463	243	61	0.4	0	1275
36	1481	1482	236	62	0.5	0	1267
36	1477	1465	242	62	0.4	0	1278
36	1487	1469	235	62	0.5	0	1277
36	1478	1472	239	60	0.4	0	1109
36	1471	1468	236	60	0.4	0	1106
36	1476	1476	244	60	0.4	0	1116
36	1491	1491	241	60	0.4	0	1106
37	1573	1560	241	64	0.2	0	1732
37	1568	1553	222	65	0.3	0	1733
37	1568	1553	225	65	0.2	0	1731
37	1529	1519	234	64	0.3	0	1456
37	1570	1554	241	63	0.4	0	1471
37	1528	1520	218	64	0.2	0	1466
37	1527	1530	244	62	0.3	0	1293
37	1525	1530	226	62	0.2	0	1296
37	1496	1503	236	62	0.3	0	1298
37	1521	1527	236	62	0.4	0	1291
37	1498	1501	240	61	0.2	0	1129
37	1510	1514	236	61	0.1	0	1131
37	1497	1509	243	60	0.3	0	1131

EGT = Exhaust gas temperature
Gr = Grains of moisture per pound of dry air

Table B-101. Detonation-Onset Engine Parameters, Part 101

Blend	Fuel Flow (lb/hr)	Brake Horsepower	Air-to-Fuel Ratio (average)	Equivalence Ratio	Brake-Specific Fuel Consumption (lb/hp hr)	Manifold Absolute Pressure (inHg)	Brake Mean Effective Pressure (psi)
38	159.4	272.1	10.69	1.283	0.586	29.66	147.4
38	159.2	273.6	10.76	1.275	0.582	29.69	148.3
38	158.4	274.0	10.81	1.269	0.578	29.70	148.4
38	131.9	235.9	11.05	1.242	0.559	27.35	132.9
38	134.4	234.9	10.96	1.252	0.572	27.32	132.1
38	135.0	235.0	10.90	1.259	0.576	27.33	132.3
38	115.3	208.7	11.26	1.219	0.553	26.07	124.6
38	113.8	209.5	11.31	1.213	0.543	26.10	125.1
38	118.5	209.4	11.00	1.248	0.566	26.10	125.0
38	97.4	179.6	11.53	1.190	0.542	24.17	111.8
38	101.3	180.1	11.17	1.229	0.562	24.18	112.1
38	99.3	180.3	11.36	1.208	0.550	24.17	112.2
39	155.6	269.4	10.86	1.286	0.578	29.50	145.9
39	156.0	270.0	10.89	1.282	0.578	29.51	146.3
39	156.3	268.5	10.89	1.282	0.582	29.51	145.4
39	133.2	235.6	11.08	1.260	0.564	27.52	132.1
39	136.3	236.0	10.95	1.275	0.577	27.55	132.8
39	136.6	235.1	10.88	1.283	0.581	27.53	132.2
39	117.6	207.7	11.12	1.255	0.566	26.21	124.0
39	117.8	207.3	11.10	1.258	0.568	26.19	123.8
39	119.6	206.9	11.02	1.267	0.577	26.18	123.5
39	101.7	179.9	11.33	1.233	0.568	24.43	112.1
39	102.5	179.9	11.27	1.239	0.571	24.42	111.9
39	101.7	180.3	11.33	1.232	0.566	24.42	112.2
40	150.5	268.2	11.19	1.262	0.560	29.52	145.1
40	148.5	269.4	11.32	1.247	0.550	29.53	145.9
40	148.4	270.0	11.37	1.242	0.550	29.51	146.2
40	129.4	235.9	11.39	1.240	0.549	27.61	132.7
40	129.2	236.8	11.45	1.233	0.546	27.60	133.2
40	127.3	237.1	11.57	1.220	0.537	27.63	133.4
40	114.2	208.7	11.43	1.235	0.548	26.33	124.6
40	114.4	208.3	11.31	1.249	0.548	26.32	124.3
40	113.0	209.1	11.53	1.225	0.542	26.31	125.0
40	92.5	178.9	12.08	1.169	0.519	24.19	111.3
40	95.9	179.1	11.72	1.205	0.534	24.21	111.4
40	91.9	180.0	12.18	1.159	0.511	24.29	112.4

Table B-102. Detonation-Onset Engine Parameters, Part 102

Blend	Engine Speed (rpm)	Engine Torque (ft-lb)	Fuel Flow (gal/hr)	Engine Inlet Air Temperature (°F)	Engine Inlet Air Pressure (inHg)	Test Cell Barometer (inHg)	Engine Cowling Temperature (°F)
38	2699	529	24.5	105	30.14	30.15	116
38	2699	532	24.7	106	30.16	30.15	116
38	2700	533	24.6	106	30.17	30.15	115
38	2600	477	20.5	105	30.16	30.15	116
38	2600	474	20.8	105	30.16	30.15	115
38	2599	475	20.8	105	30.16	30.15	115
38	2450	447	17.9	105	30.15	30.15	115
38	2450	449	17.6	105	30.15	30.15	115
38	2450	448	18.4	105	30.15	30.15	116
38	2350	401	15.1	105	30.13	30.15	115
38	2350	402	15.7	105	30.15	30.15	116
38	2350	403	15.4	105	30.14	30.15	116
39	2700	524	25.3	105	29.98	29.98	116
39	2700	525	25.4	105	29.99	29.98	116
39	2700	522	25.7	105	29.99	29.98	117
39	2600	475	21.9	106	30	29.98	115
39	2600	476	22.1	106	30.01	29.98	116
39	2600	475	22.1	106	30	29.98	117
39	2450	445	19.2	106	30	29.99	116
39	2450	444	19.3	106	29.99	29.99	115
39	2450	443	19.5	106	29.99	29.99	115
39	2350	403	16.5	104	29.99	29.99	113
39	2350	402	16.6	105	29.99	29.99	115
39	2350	403	16.5	105	30	29.99	116
40	2700	521	23.9	105	29.98	29.97	117
40	2700	524	24.1	105	29.98	29.97	116
40	2700	525	23.9	105	29.97	29.97	117
40	2600	477	20.8	105	29.98	29.97	117
40	2601	478	20.8	104	29.98	29.97	116
40	2600	479	20.4	104	29.99	29.97	116
40	2450	447	18.3	105	29.99	29.98	116
40	2450	446	18.6	105	29.99	29.97	116
40	2451	449	18.1	105	29.98	29.97	118
40	2350	400	14.8	105	29.97	29.98	116
40	2351	400	15.4	105	29.98	29.98	118
40	2351	404	14.7	105	29.98	29.98	116

Table B-103. Detonation-Onset Engine Parameters, Part 103

Blend	Fuel Temperature (°F)	Fuel Density (lb/gal)	Metered Fuel Pressure (psi)	Unmetered Fuel Pressure (psi)	CHT 1 (°F)	CHT 2 (°F)	CHT 3 (°F)
38	50	6.46	8.5	25.5	470	463	459
38	51	6.45	8.4	25.5	469	464	461
38	52	6.45	8.3	25.2	472	462	463
38	52	6.45	6.0	25.5	465	460	457
38	51	6.45	6.1	25.5	469	461	458
38	51	6.46	6.2	25.5	471	462	458
38	51	6.46	4.6	25.4	464	454	452
38	51	6.45	4.6	25.4	462	454	451
38	52	6.45	4.9	25.4	463	454	451
38	51	6.45	3.4	25.4	463	455	454
38	50	6.46	3.7	25.4	463	453	454
38	50	6.46	3.5	25.4	464	454	454
39	58	6.13	8.5	25.3	476	453	462
39	57	6.14	8.5	25.3	476	460	469
39	57	6.14	8.5	25.3	478	460	470
39	56	6.14	6.4	25.4	467	451	459
39	57	6.14	6.5	25.4	472	451	459
39	58	6.13	6.6	25.4	469	451	460
39	56	6.14	5.0	25.2	464	451	462
39	56	6.14	5.0	25.2	466	451	461
39	55	6.14	5.1	25.2	465	450	459
39	57	6.14	3.8	25.2	462	450	461
39	57	6.14	3.8	25.1	466	452	463
39	57	6.14	3.8	25.2	466	451	463
40	57	6.24	8.0	25.4	476	458	468
40	57	6.24	7.7	25.5	475	458	467
40	58	6.24	7.8	25.5	475	455	467
40	59	6.23	6.0	25.5	476	460	468
40	59	6.23	6.0	25.4	477	454	463
40	58	6.24	5.8	25.5	475	458	467
40	56	6.24	4.8	25.4	472	456	462
40	57	6.24	4.9	25.4	474	457	465
40	58	6.24	4.7	25.4	475	456	463
40	57	6.24	3.3	25.4	466	452	458
40	59	6.23	3.5	25.4	464	451	458
40	58	6.24	3.3	25.4	467	450	457

CHT = Cylinder head temperature

Table B-104. Detonation-Onset Engine Parameters, Part 104

Blend	CHT 4 (°F)	CHT 5 (°F)	CHT 6 (°F)	EGT 1 (°F)	EGT 2 (°F)	EGT 3 (°F)	EGT 4 (°F)
38	467	459	476	1433	1437	1467	1437
38	467	461	478	1432	1438	1470	1442
38	468	461	476	1446	1443	1478	1447
38	463	455	475	1412	1433	1454	1427
38	467	457	475	1413	1432	1453	1423
38	465	457	475	1407	1426	1445	1417
38	461	453	475	1392	1420	1430	1413
38	461	454	476	1401	1424	1438	1420
38	463	451	475	1375	1402	1412	1393
38	463	455	475	1399	1433	1439	1424
38	464	457	475	1379	1412	1417	1401
38	464	456	475	1390	1425	1428	1415
39	466	460	473	1433	1405	1460	1429
39	473	466	475	1430	1409	1461	1435
39	475	468	476	1426	1411	1462	1432
39	465	457	475	1395	1388	1433	1403
39	463	457	475	1390	1380	1427	1402
39	463	457	475	1383	1376	1422	1394
39	466	456	475	1362	1365	1400	1381
39	467	457	475	1368	1370	1402	1384
39	467	455	475	1358	1364	1397	1379
39	464	457	474	1366	1370	1403	1387
39	467	459	475	1360	1366	1399	1382
39	468	459	475	1364	1369	1401	1380
40	470	470	474	1440	1415	1473	1440
40	469	467	472	1455	1432	1489	1456
40	468	467	471	1452	1426	1485	1452
40	469	467	476	1417	1410	1454	1425
40	464	462	470	1410	1400	1451	1419
40	469	465	473	1425	1416	1466	1438
40	466	462	474	1379	1386	1418	1400
40	467	463	475	1370	1375	1410	1391
40	467	464	474	1387	1391	1423	1404
40	464	460	475	1409	1416	1450	1425
40	464	459	476	1384	1393	1422	1406
40	462	458	475	1411	1420	1452	1431

CHT = Cylinder head temperature
EGT = Exhaust gas temperature

Table B-105. Detonation-Onset Engine Parameters, Part 105

Blend	EGT 5 (°F)	EGT 6 (°F)	Oil Inlet Temperature (°F)	Oil Pressure (psi)	Engine Inlet Air Humidity Ratio (Gr/lb)	Engine Inlet Air Relative Humidity (%)	Engine Intake Airflow (lb/hr)
38	1456	1448	235	66	0.4	0	1715
38	1460	1448	226	66	0.4	0	1720
38	1463	1461	242	65	0.3	0	1719
38	1446	1444	220	65	0.5	0	1449
38	1444	1441	247	64	0.5	0	1451
38	1435	1437	242	65	0.5	0	1453
38	1424	1430	242	63	0.4	0	1275
38	1425	1432	234	62	0.4	0	1285
38	1405	1409	221	63	0.4	0	1278
38	1423	1436	236	62	0.4	0	1113
38	1402	1415	243	62	0.4	0	1116
38	1415	1431	224	62	0.4	0	1118
39	1452	1438	242	65	0.5	0	1702
39	1456	1447	236	66	0.5	0	1703
39	1455	1444	240	66	0.5	0	1692
39	1433	1423	221	65	0.5	0	1457
39	1426	1418	219	65	0.5	0	1462
39	1419	1407	235	65	0.5	0	1461
39	1395	1394	225	63	0.5	0	1283
39	1397	1400	241	63	0.5	0	1279
39	1396	1393	241	63	0.5	0	1279
39	1389	1402	232	63	0.5	0	1125
39	1388	1399	236	62	0.4	0	1123
39	1391	1398	225	63	0.5	0	1115
40	1464	1454	242	66	0.6	0	1693
40	1482	1463	244	65	0.6	0	1688
40	1473	1456	244	65	0.7	0	1702
40	1454	1445	235	65	0.6	0	1454
40	1447	1431	228	65	0.6	0	1454
40	1466	1452	222	65	0.6	0	1456
40	1416	1418	243	63	0.6	0	1285
40	1401	1403	231	63	0.6	0	1281
40	1417	1421	225	62	0.5	0	1284
40	1436	1446	217	62	0.5	0	1103
40	1414	1422	240	62	0.6	0	1108
40	1442	1446	218	62	0.6	0	1120

EGT = Exhaust gas temperature
Gr = Grains of moisture per pound of dry air

Table B-106. Detonation-Onset Engine Parameters, Part 106

Blend	Fuel Flow (lb/hr)	Brake Horsepower	Air-to-Fuel Ratio (average)	Equivalence Ratio	Brake-Specific Fuel Consumption (lb/hp hr)	Manifold Absolute Pressure (inHg)	Brake Mean Effective Pressure (psi)
41	129.5	268.8	12.85	1.088	0.482	29.53	145.6
41	106.2	231.9	13.37	1.046	0.458	27.54	130.5
41	89.2	201.8	13.99	0.999	0.442	26.56	120.4
41	90.8	203.2	13.68	1.022	0.447	26.34	121.3
41	80.6	176.9	13.51	1.035	0.455	24.55	110.1
41	78.7	174.9	13.68	1.022	0.450	24.57	108.8
41	79.0	175.1	13.80	1.013	0.451	24.57	109.0
41	103.3	228.8	13.58	1.030	0.452	27.56	128.7
42	151.5	273.5	11.17	1.231	0.554	29.66	148.1
42	150.7	273.3	11.13	1.235	0.551	29.68	148.1
42	148.6	272.8	11.22	1.225	0.545	29.69	147.8
42	127.1	235.9	11.47	1.198	0.539	27.47	132.7
42	124.6	236.9	11.67	1.177	0.526	27.48	133.3
42	125.0	235.6	11.63	1.182	0.531	27.49	132.5
42	109.2	206.6	11.70	1.174	0.529	26.19	123.3
42	110.1	208.8	11.68	1.176	0.527	26.19	124.6
42	109.5	206.8	11.69	1.175	0.529	26.15	123.5
42	94.6	179.4	11.85	1.160	0.526	24.34	111.6
42	97.5	179.8	11.57	1.188	0.542	24.36	111.9
42	94.8	180.0	11.85	1.159	0.527	24.35	112.0
43	138.5	275.6	12.24	1.170	0.502	30.03	148.1
43	139.7	275.7	12.28	1.166	0.507	30.05	150.2
43	138.6	275.4	12.30	1.164	0.504	30.05	149.3
43	139.0	275.3	12.24	1.170	0.505	30.05	149.2
43	134.9	271.4	12.44	1.152	0.497	29.66	147.0
43	134.6	269.1	12.26	1.168	0.502	29.66	146.5
43	114.5	236.4	12.79	1.120	0.483	27.76	133.9
43	116.7	237.2	12.55	1.141	0.492	27.76	134.1

Table B-107. Detonation-Onset Engine Parameters, Part 107

Blend	Engine Speed (rpm)	Engine Torque (ft-lb)	Fuel Flow (gal/hr)	Engine Inlet Air Temperature (°F)	Engine Inlet Air Pressure (inHg)	Test Cell Barometer (inHg)	Engine Cowling Temperature (°F)
41	2700	523	19.8	105	29.96	29.94	118
41	2600	468	16.4	105	29.95	29.95	118
41	2451	432	13.8	105	29.97	29.95	116
41	2450	436	14.1	105	29.97	29.95	115
41	2350	394	12.5	105	29.95	29.96	116
41	2350	391	12.2	105	29.96	29.96	116
41	2350	393	12.3	105	29.95	29.96	117
41	2600	462	16.0	105	29.97	29.95	115
42	2700	532	23.8	105	30.16	30.17	114
42	2700	532	23.7	104	30.18	30.17	116
42	2700	531	23.4	105	30.18	30.16	114
42	2600	476	20.0	104	30.17	30.16	116
42	2600	479	19.6	104	30.18	30.16	116
42	2600	476	19.7	104	30.18	30.16	115
42	2450	443	17.2	104	30.18	30.16	116
42	2450	448	17.3	104	30.18	30.16	115
42	2450	443	17.2	104	30.18	30.16	114
42	2350	401	14.9	104	30.14	30.16	115
42	2350	402	15.3	104	30.17	30.16	116
42	2350	402	14.9	104	30.17	30.16	115
43	2700	540	21.3	102	30.51	30.5	114
43	2700	539	22.0	103	30.52	30.49	117
43	2699	536	21.0	103	30.52	30.49	116
43	2699	536	21.7	102	30.52	30.5	115
43	2700	528	20.9	106	30.17	30.16	115
43	2700	526	20.8	106	30.17	30.16	115
43	2599	478	17.9	102	30.51	30.49	116
43	2600	481	18.2	102	30.5	30.49	115

Table B-108. Detonation-Onset Engine Parameters, Part 108

Blend	Fuel Temperature (°F)	Fuel Density (lb/gal)	Metered Fuel Pressure (psi)	Unmetered Fuel Pressure (psi)	CHT 1 (°F)	CHT 2 (°F)	CHT 3 (°F)
41	58	6.45	5.6	25.8	478	460	470
41	58	6.46	4.1	25.8	469	455	462
41	57	6.46	3.1	25.7	470	452	464
41	59	6.45	3.1	25.7	471	453	457
41	59	6.45	2.6	25.5	466	454	463
41	58	6.46	2.5	25.6	468	456	461
41	57	6.46	2.5	25.6	468	455	464
41	57	6.46	3.9	25.8	471	455	462
42	52	6.35	7.9	25.5	469	468	466
42	51	6.36	7.9	25.5	468	471	470
42	50	6.36	7.7	25.5	468	468	474
42	50	6.36	5.7	25.5	467	468	459
42	50	6.36	5.5	25.6	471	471	461
42	51	6.36	5.6	25.5	472	469	465
42	52	6.36	4.4	25.5	467	461	460
42	51	6.36	4.4	25.5	466	460	460
42	50	6.36	4.4	25.4	467	460	459
42	49	6.36	3.4	25.4	466	466	465
42	49	6.36	3.5	25.4	466	464	466
42	50	6.36	3.4	25.4	466	463	465
43	51	6.45	6.5	25.8	466	461	476
43	52	6.45	6.4	25.9	469	463	480
43	54	6.44	6.3	25.9	469	460	477
43	53	6.44	6.4	25.9	469	460	476
43	50	6.46	6.3	25.7	471	475	476
43	51	6.45	6.4	25.6	470	478	484
43	52	6.45	4.5	25.8	465	460	476
43	53	6.44	4.6	25.8	464	460	480

CHT = Cylinder head temperature

Table B-109. Detonation-Onset Engine Parameters, Part109

Blend	CHT 4 (°F)	CHT 5 (°F)	CHT 6 (°F)	EGT 1 (°F)	EGT 2 (°F)	EGT 3 (°F)	EGT 4 (°F)
41	476	472	477	1579	1564	1618	1579
41	465	460	476	1575	1558	1617	1579
41	464	457	476	1564	1563	1595	1580
41	465	458	475	1546	1552	1588	1569
41	466	463	475	1524	1539	1564	1541
41	469	463	475	1541	1549	1579	1553
41	469	463	476	1532	1548	1575	1551
41	466	461	477	1595	1580	1633	1596
42	463	459	476	1464	1472	1504	1470
42	463	459	476	1470	1476	1503	1470
42	463	459	476	1473	1480	1509	1478
42	462	459	475	1444	1468	1486	1452
42	463	459	475	1458	1481	1499	1468
42	465	460	475	1457	1480	1499	1467
42	465	458	476	1428	1456	1462	1439
42	462	457	475	1418	1451	1458	1435
42	462	458	475	1422	1455	1457	1434
42	467	461	475	1417	1449	1452	1434
42	467	459	475	1405	1438	1443	1425
42	467	459	475	1418	1451	1455	1439
43	456	473	468	1506	1471	1538	1512
43	460	480	473	1508	1474	1540	1514
43	459	478	472	1515	1485	1550	1517
43	458	479	473	1514	1481	1550	1519
43	464	460	477	1523	1522	1547	1523
43	467	462	479	1511	1523	1550	1519
43	454	468	464	1494	1474	1524	1502
43	454	469	463	1479	1459	1518	1487

CHT = Cylinder head temperature
EGT = Exhaust gas temperature

Table B-110. Detonation-Onset Engine Parameters, Part 110

Blend	EGT 5 (°F)	EGT 6 (°F)	Oil Inlet Temperature (°F)	Oil Pressure (psi)	Engine Inlet Air Humidity Ratio (Gr/lb)	Engine Inlet Air Relative Humidity (%)	Engine Intake Airflow (lb/hr)
41	1605	1588	237	65	0.7	0	1688
41	1610	1586	220	65	0.7	0	1444
41	1583	1582	233	64	0.6	0	1288
41	1579	1578	237	64	0.6	0	1274
41	1550	1552	239	62	0.7	0	1117
41	1563	1562	240	62	0.6	0	1116
41	1559	1562	231	63	0.6	0	1124
41	1625	1609	232	65	0.6	0	1448
42	1496	1481	244	66	0.4	0	1717
42	1487	1479	223	66	0.3	0	1728
42	1499	1487	227	66	0.3	0	1707
42	1475	1469	220	66	0.3	0	1449
42	1492	1482	232	65	0.3	0	1459
42	1483	1481	238	66	0.4	0	1456
42	1458	1461	247	63	0.4	0	1276
42	1450	1456	240	64	0.4	0	1274
42	1449	1455	234	64	0.4	0	1283
42	1440	1455	243	63	0.4	0	1121
42	1431	1444	243	63	0.5	0	1128
42	1443	1454	230	63	0.3	0	1122
43	1528	1509	231	64	0.2	0	1745
43	1529	1515	239	65	0.1	0	1734
43	1537	1520	240	65	0.3	0	1735
43	1539	1519	239	64	0.3	0	1739
43	1543	1532	236	66	0.4	0	1702
43	1542	1527	222	67	0.3	0	1694
43	1526	1511	247	63	0.3	0	1461
43	1512	1499	236	65	0.3	0	1462

EGT = Exhaust gas temperature
Gr = Grains of moisture per pound of dry air

Table B-111. Detonation-Onset Engine Parameters, Part 111

Blend	Fuel Flow (lb/hr)	Brake Horsepower	Air-to-Fuel Ratio (average)	Equivalence Ratio	Brake-Specific Fuel Consumption (lb/hp hr)	Manifold Absolute Pressure (inHg)	Brake Mean Effective Pressure (psi)
43	117.6	237.6	12.50	1.146	0.495	27.75	133.5
43	115.2	236.5	12.76	1.122	0.487	27.87	133.0
43	115.0	238.2	12.63	1.134	0.483	27.87	134.0
43	101.2	211.4	12.83	1.116	0.479	26.56	126.2
43	101.9	211.2	12.80	1.119	0.482	26.59	126.1
43	100.7	210.4	12.90	1.111	0.479	26.60	126.0
43	103.8	210.2	12.39	1.156	0.494	26.49	125.5
43	100.8	209.8	12.71	1.127	0.480	26.47	125.2
43	99.1	211.0	12.89	1.111	0.469	26.63	126.0
43	100.1	210.3	12.79	1.120	0.476	26.53	125.5
43	87.8	180.6	12.91	1.109	0.486	24.60	112.4
43	86.0	180.3	13.11	1.093	0.477	24.59	112.2
43	86.1	180.5	13.08	1.095	0.477	24.60	112.4
44	145.7	273.9	11.44	1.188	0.532	29.69	148.4
44	147.5	273.6	11.22	1.212	0.539	29.70	148.4
44	150.0	273.7	11.14	1.220	0.549	29.71	148.2
44	122.7	236.9	11.74	1.158	0.518	27.56	133.3
44	121.1	236.1	11.88	1.144	0.514	27.55	132.6
44	106.0	210.4	12.05	1.128	0.504	26.30	125.6
44	107.6	208.5	11.83	1.149	0.515	26.27	124.5
44	110.2	209.4	11.66	1.166	0.526	26.29	125.0
44	88.4	178.8	12.42	1.094	0.495	24.29	111.3
44	91.6	180.3	12.20	1.114	0.508	24.42	112.2
44	92.8	179.7	12.08	1.125	0.516	24.40	111.9
44	90.3	178.8	12.39	1.097	0.504	24.37	110.0
45	148.8	271.7	11.34	1.255	0.549	29.71	147.2
45	146.9	271.6	11.43	1.244	0.541	29.72	147.1
45	149.0	272.1	11.34	1.255	0.547	29.72	147.5

Table B-112. Detonation-Onset Engine Parameters, Part 112

Blend	Engine Speed (rpm)	Engine Torque (ft-lb)	Fuel Flow (gal/hr)	Engine Inlet Air Temperature (°F)	Engine Inlet Air Pressure (inHg)	Test Cell Barometer (inHg)	Engine Cowling Temperature (°F)
43	2599	478	18.6	102	30.5	30.5	115
43	2599	477	18.1	102	30.5	30.49	117
43	2600	481	17.8	105	30.17	30.16	115
43	2450	446	15.9	102	30.51	30.49	116
43	2450	453	15.9	103	30.51	30.49	115
43	2449	452	15.8	102	30.51	30.49	116
43	2450	449	16.4	106	30.15	30.16	113
43	2450	448	15.8	106	30.16	30.16	114
43	2450	452	15.3	106	30.17	30.16	115
43	2450	451	15.5	106	30.15	30.16	114
43	2349	404	13.6	103	30.5	30.49	116
43	2350	403	13.3	102	30.49	30.49	116
43	2350	404	13.6	102	30.51	30.49	115
44	2700	533	22.2	105	30.16	30.16	115
44	2700	533	22.8	105	30.18	30.16	116
44	2701	532	22.7	105	30.18	30.16	115
44	2600	479	18.6	104	30.18	30.16	116
44	2600	477	18.6	104	30.17	30.16	115
44	2450	451	16.1	104	30.18	30.16	115
44	2450	447	16.4	104	30.17	30.16	116
44	2451	449	16.7	104	30.18	30.16	115
44	2350	400	13.4	104	30.17	30.16	114
44	2350	403	13.9	104	30.16	30.16	115
44	2350	402	14.0	104	30.17	30.16	116
44	2351	395	13.7	104	30.15	30.17	115
45	2701	528	23.2	105	30.18	30.17	115
45	2700	528	22.9	104	30.18	30.17	117
45	2701	530	23.2	104	30.18	30.17	116

Table B-113. Detonation-Onset Engine Parameters, Part 113

Blend	Fuel Temperature (°F)	Fuel Density (lb/gal)	Metered Fuel Pressure (psi)	Unmetered Fuel Pressure (psi)	CHT 1 (°F)	CHT 2 (°F)	CHT 3 (°F)
43	54	6.44	4.8	25.8	460	454	476
43	53	6.44	4.6	25.8	468	465	485
43	50	6.46	4.8	25.6	470	474	475
43	54	6.44	3.6	25.7	470	463	475
43	52	6.44	3.6	25.7	471	468	472
43	51	6.45	3.6	25.7	470	463	475
43	51	6.45	4.1	25.5	468	467	462
43	50	6.46	3.9	25.5	467	468	461
43	49	6.46	3.7	25.6	467	466	470
43	51	6.45	3.7	25.5	468	466	464
43	51	6.45	2.7	25.7	470	464	474
43	52	6.45	2.6	25.7	471	464	475
43	52	6.44	2.7	25.7	472	466	474
44	53	6.6	7.1	25.7	470	468	463
44	52	6.59	7.4	25.7	467	468	461
44	52	6.6	7.6	25.6	471	470	462
44	50	6.6	5.3	25.7	470	466	465
44	52	6.6	5.2	25.6	472	468	470
44	51	6.6	4.0	25.6	468	461	466
44	52	6.6	4.2	25.6	467	461	462
44	52	6.6	4.3	25.6	466	460	462
44	51	6.6	3.0	25.5	461	464	475
44	51	6.6	3.1	25.5	464	464	472
44	49	6.61	3.1	25.5	465	459	469
44	50	6.6	3.0	25.5	465	459	466
45	51	6.4	7.6	25.6	474	468	464
45	52	6.39	7.5	25.6	470	469	465
45	53	6.41	7.6	25.6	472	469	465

CHT = Cylinder head temperature

Table B-114. Detonation-Onset Engine Parameters, Part 114

Blend	CHT 4 (°F)	CHT 5 (°F)	CHT 6 (°F)	EGT 1 (°F)	EGT 2 (°F)	EGT 3 (°F)	EGT 4 (°F)
43	448	463	458	1470	1450	1500	1480
43	458	472	467	1485	1474	1515	1502
43	467	460	476	1492	1512	1529	1497
43	463	476	469	1457	1445	1487	1468
43	468	476	473	1457	1445	1496	1469
43	464	476	471	1448	1450	1494	1473
43	469	459	475	1425	1455	1460	1440
43	472	459	476	1447	1473	1482	1458
43	472	458	475	1466	1492	1490	1478
43	472	457	475	1463	1489	1496	1474
43	463	475	469	1458	1453	1484	1478
43	464	474	473	1470	1468	1498	1491
43	465	475	474	1456	1456	1486	1476
44	465	461	477	1506	1512	1541	1510
44	465	460	479	1490	1496	1526	1497
44	466	462	479	1482	1491	1511	1493
44	464	459	476	1479	1501	1517	1485
44	466	460	475	1482	1505	1525	1492
44	462	457	476	1461	1488	1490	1471
44	461	457	475	1446	1477	1485	1461
44	465	455	476	1438	1469	1474	1450
44	463	458	472	1475	1498	1497	1482
44	461	459	475	1456	1489	1483	1473
44	462	459	475	1448	1482	1471	1468
44	461	458	475	1468	1502	1499	1485
45	466	461	476	1462	1459	1491	1463
45	468	463	476	1459	1466	1498	1466
45	470	463	476	1456	1460	1492	1460

CHT = Cylinder head temperature
EGT = Exhaust gas temperature

Table B-115. Detonation-Onset Engine Parameters, Part 115

Blend	EGT 5 (°F)	EGT 6 (°F)	Oil Inlet Temperature (°F)	Oil Pressure (psi)	Engine Inlet Air Humidity Ratio (Gr/lb)	Engine Inlet Air Relative Humidity (%)	Engine Intake Airflow (lb/hr)
43	1500	1489	243	64	0.2	0	1462
43	1524	1507	223	65	0.3	0	1460
43	1527	1518	245	65	0.4	0	1469
43	1482	1482	240	63	0.3	0	1293
43	1485	1485	232	63	0.2	0	1295
43	1490	1486	243	62	0.2	0	1298
43	1455	1460	239	64	0.4	0	1278
43	1477	1484	220	63	0.3	0	1285
43	1496	1505	222	64	0.4	0	1289
43	1495	1500	238	64	0.3	0	1283
43	1485	1488	220	61	0.1	0	1118
43	1497	1497	243	61	0.2	0	1118
43	1483	1485	241	61	0.2	0	1108
44	1528	1521	243	66	0.5	0	1710
44	1514	1508	232	67	0.4	0	1706
44	1505	1501	227	66	0.4	0	1709
44	1508	1503	246	65	0.4	0	1450
44	1515	1506	242	64	0.4	0	1453
44	1489	1495	234	63	0.4	0	1289
44	1475	1481	245	63	0.4	0	1286
44	1467	1472	226	64	0.3	0	1286
44	1487	1504	245	62	0.4	0	1124
44	1474	1488	229	62	0.4	0	1123
44	1473	1485	244	62	0.4	0	1127
44	1493	1501	234	63	0.5	0	1117
45	1479	1471	228	67	0.4	0	1710
45	1489	1479	245	66	0.4	0	1710
45	1478	1470	246	66	0.5	0	1715

EGT = Exhaust gas temperature
Gr = Grains of moisture per pound of dry air

Table B-116. Detonation-Onset Engine Parameters, Part 116

Blend	Fuel Flow (lb/hr)	Brake Horsepower	Air-to-Fuel Ratio (average)	Equivalence Ratio	Brake-Specific Fuel Consumption (lb/hp hr)	Manifold Absolute Pressure (inHg)	Brake Mean Effective Pressure (psi)
45	123.3	237.2	11.83	1.203	0.520	27.72	133.4
45	127.6	237.1	11.58	1.228	0.538	27.73	133.4
45	124.7	237.0	11.77	1.209	0.525	27.74	133.3
45	110.8	210.1	11.76	1.209	0.527	26.52	125.4
45	105.9	209.9	12.12	1.173	0.503	26.42	125.3
45	106.6	209.9	12.09	1.177	0.508	26.41	125.3
45	91.8	181.0	12.36	1.151	0.507	24.53	112.6
45	94.4	180.8	12.07	1.179	0.522	24.53	112.5
45	93.6	180.7	12.14	1.171	0.518	24.52	112.5
46	165.2	263.9	10.65	1.408	0.626	29.70	143.0
46	166.2	263.3	10.60	1.415	0.632	29.71	142.4
46	164.5	264.6	10.71	1.400	0.622	29.71	143.3
46	140.5	232.2	10.97	1.366	0.605	27.82	130.6
46	137.4	233.4	11.17	1.342	0.588	27.84	131.3
46	140.3	232.7	11.01	1.361	0.603	27.84	130.9
46	120.6	208.4	11.29	1.328	0.579	26.57	124.4
46	120.5	208.4	11.30	1.327	0.578	26.61	124.4
46	121.4	207.7	11.24	1.334	0.584	26.61	124.0
46	103.6	179.6	11.44	1.310	0.577	24.64	111.7
46	103.6	179.8	11.40	1.315	0.576	24.64	111.9
46	106.0	179.4	11.28	1.329	0.591	24.62	111.7
45	123.3	237.2	11.83	1.203	0.520	27.72	133.4
45	127.6	237.1	11.58	1.228	0.538	27.73	133.4
45	124.7	237.0	11.77	1.209	0.525	27.74	133.3
45	110.8	210.1	11.76	1.209	0.527	26.52	125.4
45	105.9	209.9	12.12	1.173	0.503	26.42	125.3
45	106.6	209.9	12.09	1.177	0.508	26.41	125.3
45	91.8	181.0	12.36	1.151	0.507	24.53	112.6
45	94.4	180.8	12.07	1.179	0.522	24.53	112.5
45	93.6	180.7	12.14	1.171	0.518	24.52	112.5
46	165.2	263.9	10.65	1.408	0.626	29.70	143.0
46	166.2	263.3	10.60	1.415	0.632	29.71	142.4
46	164.5	264.6	10.71	1.400	0.622	29.71	143.3
46	140.5	232.2	10.97	1.366	0.605	27.82	130.6
46	137.4	233.4	11.17	1.342	0.588	27.84	131.3
46	140.3	232.7	11.01	1.361	0.603	27.84	130.9
46	120.6	208.4	11.29	1.328	0.579	26.57	124.4
46	121.4	207.7	11.24	1.334	0.584	26.61	124.0

Table B-116. Detonation-Onset Engine Parameters, Part 116 (Continued)

Blend	Fuel Flow (lb/hr)	Brake Horsepower	Air-to-Fuel Ratio (average)	Equivalence Ratio	Brake-Specific Fuel Consumption (lb/hp hr)	Manifold Absolute Pressure (inHg)	Brake Mean Effective Pressure (psi)
46	103.6	179.6	11.44	1.310	0.577	24.64	111.7
46	103.6	179.8	11.40	1.315	0.576	24.64	111.9
46	106.0	179.4	11.28	1.329	0.591	24.62	111.7

Table B-117. Detonation-Onset Engine Parameters, Part 117

Blend	Fuel Temperature (°F)	Fuel Density (lb/gal)	Metered Fuel Pressure (psi)	Unmetered Fuel Pressure (psi)	CHT 1 (°F)	CHT 2 (°F)	CHT 3 (°F)
45	51	6.4	5.4	25.6	470	468	462
45	50	6.4	5.7	25.6	471	468	462
45	50	6.4	5.5	25.6	473	469	463
45	50	6.4	4.4	25.5	466	462	459
45	52	6.39	4.2	25.5	466	462	457
45	52	6.39	4.2	25.5	466	462	457
45	51	6.4	3.1	25.5	465	460	461
45	49	6.4	3.3	25.5	465	459	459
45	49	6.4	3.3	25.5	464	459	458
46	51	5.95	9.9	25.3	472	472	465
46	52	5.95	10.0	25.3	471	472	466
46	53	5.94	9.7	25.3	469	474	466
46	51	5.95	7.2	25.3	467	466	461
46	50	5.95	6.9	25.3	469	468	463
46	50	5.95	7.2	25.3	469	468	464
46	52	5.95	5.4	25.3	465	461	457
46	52	5.95	5.4	25.2	465	463	458
46	52	5.95	5.5	25.2	464	463	458
46	50	5.95	4.1	25.3	462	461	459
46	51	5.95	4.2	25.3	463	461	459
46	51	5.95	4.2	25.3	463	460	457

CHT = Cylinder head temperature

Table B-118. Detonation-Onset Engine Parameters, Part 118

Blend	CHT 4 (°F)	CHT 5 (°F)	CHT 6 (°F)	EGT 1 (°F)	EGT 2 (°F)	EGT 3 (°F)	EGT 4 (°F)
45	467	462	475	1446	1465	1488	1453
45	465	460	475	1433	1451	1479	1445
45	466	461	476	1444	1462	1487	1454
45	463	459	476	1406	1437	1446	1421
45	465	458	476	1425	1452	1462	1432
45	468	458	475	1422	1453	1463	1436
45	462	458	475	1430	1462	1467	1449
45	461	458	475	1407	1439	1445	1426
45	462	458	475	1415	1447	1451	1435
46	466	461	474	1343	1345	1367	1344
46	468	463	474	1336	1345	1365	1341
46	468	461	472	1347	1354	1372	1348
46	465	460	474	1324	1347	1365	1337
46	465	461	474	1336	1359	1375	1348
46	466	462	474	1325	1348	1365	1338
46	461	458	474	1311	1339	1348	1329
46	464	457	474	1315	1339	1352	1326
46	464	457	474	1308	1336	1346	1328
46	461	457	474	1307	1342	1349	1332
46	462	457	474	1311	1340	1346	1334
46	461	456	474	1306	1337	1342	1328

CHT = Cylinder head temperature
EGT = Exhaust gas temperature

Table B-119. Detonation-Onset Engine Parameters, Part 119

Blend	EGT 5 (°F)	EGT 6 (°F)	Oil Inlet Temperature (°F)	Oil Pressure (psi)	Engine Inlet Air Humidity Ratio (Gr/lb)	Engine Inlet Air Relative Humidity (%)	Engine Intake Airflow (lb/hr)
45	1483	1477	222	66	0.4	0	1460
45	1466	1460	239	65	0.4	0	1459
45	1479	1470	245	65	0.3	0	1458
45	1434	1438	243	64	0.4	0	1298
45	1451	1458	241	64	0.5	0	1296
45	1448	1458	245	63	0.4	0	1298
45	1455	1460	242	62	0.5	0	1122
45	1430	1440	235	63	0.5	0	1130
45	1442	1448	244	62	0.4	0	1129
46	1359	1355	235	66	0.4	0	1717
46	1356	1350	241	66	0.4	0	1729
46	1367	1356	241	66	0.4	0	1731
46	1358	1356	245	65	0.4	0	1476
46	1372	1368	242	65	0.4	0	1479
46	1361	1355	237	65	0.4	0	1483
46	1343	1345	240	64	0.4	0	1307
46	1342	1344	234	64	0.4	0	1318
46	1338	1341	245	63	0.4	0	1314
46	1329	1346	243	62	0.4	0	1139
46	1331	1345	223	63	0.5	0	1151
46	1324	1337	244	62	0.4	0	1149

EGT = Exhaust gas temperature
Gr = Grains of moisture per pound of dry air

Table B-120. Detonation-Onset Engine Parameters, Part 120

Blend	Fuel Flow (lb/hr)	Brake Horsepower	Air-to-Fuel Ratio (average)	Equivalence Ratio	Brake-Specific Fuel Consumption (lb/hp hr)	Manifold Absolute Pressure (inHg)	Brake Mean Effective Pressure (psi)
47	169.1	268.2	10.30	1.362	0.630	29.70	145.2
47	169.1	269.7	10.28	1.364	0.627	29.72	146.0
47	169.9	269.1	10.30	1.361	0.631	29.72	145.8
47	140.7	233.7	10.71	1.310	0.602	27.46	131.4
47	141.8	233.6	10.63	1.320	0.608	27.49	131.4
47	141.6	233.1	10.65	1.317	0.608	27.51	131.1
47	125.8	206.3	10.62	1.320	0.610	26.21	123.2
47	124.6	206.4	10.72	1.308	0.605	26.21	123.2
47	122.2	207.8	10.88	1.289	0.589	26.22	124.1
47	107.0	177.9	10.83	1.295	0.601	24.24	110.7
47	103.1	179.0	11.16	1.256	0.576	24.28	111.3
47	106.3	178.5	10.88	1.289	0.596	24.26	111.1

Table B-121. Detonation-Onset Engine Parameters, Part 121

Blend	Engine Speed (rpm)	Engine Torque (ft-lb)	Fuel Flow (gal/hr)	Engine Inlet Air Temperature (°F)	Engine Inlet Air Pressure (inHg)	Test Cell Barometer (inHg)	Engine Cowling Temperature (°F)
47	2700	524	27.6	105	30.17	30.17	114
47	2701	524	27.8	104	30.18	30.17	116
47	2700	523	27.6	105	30.19	30.17	117
47	2600	471	22.9	104	30.18	30.17	116
47	2600	471	23.1	105	30.19	30.17	115
47	2600	471	23.0	104	30.19	30.17	115
47	2450	442	20.5	104	30.17	30.17	115
47	2450	442	20.2	104	30.17	30.17	114
47	2451	445	20.1	104	30.17	30.17	114
47	2350	398	17.4	104	30.19	30.17	115
47	2351	400	16.8	104	30.17	30.17	116
47	2350	399	17.3	104	30.17	30.17	116

Table B-122. Detonation-Onset Engine Parameters, Part 122

Blend	Fuel Temperature (°F)	Fuel Density (lb/gal)	Metered Fuel Pressure (psi)	Unmetered Fuel Pressure (psi)	CHT 1 (°F)	CHT 2 (°F)	CHT 3 (°F)
47	50	6.15	10.0	25.3	472	473	464
47	51	6.15	10.1	25.3	473	476	464
47	52	6.14	10.0	25.3	471	475	465
47	50	6.15	7.0	25.3	467	464	459
47	49	6.15	7.1	25.3	470	471	462
47	50	6.15	7.0	25.3	471	470	464
47	51	6.15	5.7	25.3	468	462	458
47	52	6.14	5.5	25.3	466	466	458
47	51	6.15	5.4	25.3	467	461	456
47	49	6.15	4.2	25.2	464	462	460
47	50	6.15	3.9	25.3	465	460	458
47	50	6.15	4.2	25.2	466	459	458

CHT = Cylinder head temperature

Table B-123. Detonation-Onset Engine Parameters, Part 123

Blend	CHT 4 (°F)	CHT 5 (°F)	CHT 6 (°F)	EGT 1 (°F)	EGT 2 (°F)	EGT 3 (°F)	EGT 4 (°F)
47	471	462	474	1376	1378	1405	1379
47	468	461	474	1375	1373	1401	1378
47	469	463	475	1374	1379	1402	1382
47	469	459	475	1358	1384	1398	1371
47	467	461	474	1356	1378	1401	1369
47	467	461	474	1356	1377	1399	1371
47	464	459	474	1327	1355	1360	1338
47	464	457	475	1336	1361	1371	1349
47	464	457	475	1339	1367	1372	1354
47	463	461	475	1325	1365	1364	1351
47	463	457	475	1345	1382	1381	1369
47	462	457	475	1326	1366	1364	1351

CHT = Cylinder head temperature
EGT = Exhaust gas temperature

Table B-124. Detonation-Onset Engine Parameters, Part 124

Blend	EGT 5 (°F)	EGT 6 (°F)	Oil Inlet Temperature (°F)	Oil Pressure (psi)	Engine Inlet Air Humidity Ratio (Gr/lb)	Engine Inlet Air Relative Humidity (%)	Engine Intake Airflow (lb/hr)
47	1393	1390	236	66	0.5	0	1727
47	1391	1386	230	65	0.5	0	1729
47	1394	1392	234	66	0.5	0	1717
47	1388	1391	219	65	0.6	0	1460
47	1393	1386	232	66	0.5	0	1447
47	1388	1384	238	65	0.5	0	1465
47	1349	1353	246	63	0.4	0	1288
47	1357	1371	243	63	0.4	0	1291
47	1363	1370	219	64	0.5	0	1290
47	1346	1363	240	62	0.5	0	1122
47	1367	1380	245	62	0.5	0	1128
47	1349	1363	230	63	0.5	0	1125

EGT = Exhaust gas temperature
Gr = Grains of moisture per pound of dry air

APPENDIX C— STOICHIOMETRIES OF 47 BLENDS

Blend	Stoichiometric Air-to-Fuel Ratio	Blend	Stoichiometric Air-to-Fuel Ratio
1	13.871	25	14.636
2	14.303	26	13.963
3	13.459	27	14.537
4	14.432	28	14.455
5	14.136	29	14.684
6	14.455	30	14.654
7	14.432	31	14.247
8	14.383	32	14.418
9	13.674	33	14.134
10	13.782	34	13.748
11	13.747	35	14.475
12	14.019	36	14.537
13	14.366	37	14.432
14	13.531	38	13.717
15	14.175	39	13.964
16	14.537	40	14.115
17	14.006	41	13.976
18	14.344	42	13.735
19	14.081	43	14.318
20	13.684	44	13.589
21	13.734	45	14.217
22	14.297	46	14.986
23	14.045	47	14.020
24	13.889	Min Spec 100LL	14.902

Min Spec = Minimum specification