

DTC Report No. 11646
Order No. 2022-10716
DTC Test No. DW10B_3-22-060 & 061
Customer Order No. VIF

Test Report

Direct Injection, Common Rail Diesel Engine Nozzle Coking Test

According to Dirty-Up and Clean-Up Test Procedure

CEC F-98-08 PSA DW10 engine

18.09.2022



DTC Testing GmbH
Drive Technology Center
Mannswörther Str. 28
A-2320 Schwechat

VIF, s.r.o.
Volutová 2523/14
15800 Praha
Czech Republic

DTC Testing GmbH
Drive Technology Center
Mannswörther Straße 28
A – 2320 Schwechat



Test No. DW10_3-22-060 & 3-22-061
Receipt of Test Fuel 12.09.2022
Start of Test 12.09.2022
End of Test 15.09.2022
Engine no 0 960 701 (reference no. 10WAJ2)
Engine runtime at Start of Test 157 h
Test Fuel Code **RF-79-07/10 + 6,35 %vol/vol FAME + 1,0 mg/kg Zinc (DU)**
EFECTA DIESEL (EN590 + 600 ml/m³ BMN3030) (CU)
Additive and CU Fuel provided by VIF, DU Fuel & blending by DTC.
Test Fuel ID 20222758 (DU)
20222759 (CU)
Test Injectors ID 1. Cylinder: 0606-03754 (Runtime before start of test: 538 h)
2. Cylinder: 0606-03758 (Runtime before start of test: 538 h)
3. Cylinder: 0606-03822 (Runtime before start of test: 538 h)
4. Cylinder: 0606-08008 (Runtime before start of test: 538 h)
Test Oil Used RL 236 / Batch 6
Test Procedure CEC F-98-08 Issue No. 11, Dirty-Up Clean-Up Test Procedure
Comment Used, but cleaned injectors were used
Test Description Direct Injection, Common Rail Diesel Engine Nozzle Coking Test
Test Validity **OK**
Test Result - **5,01 %** Power change during Dirty-Up
+ **4,87 %** Power change during Clean-Up
+ **1,08 %** Power change during Dirty-Up and Clean-Up
Negative values are corresponding to a power loss and positive values to a power gain

Schwechat, 18.09.2022

David Weissenberger
Laboratory Manager

Jakob Krause
Technical Expert

The test results refer to the tested samples only. The partial publication of this reports needs a written acceptance of the testing laboratory. Retain samples are only provided on special request by the customer.

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Operational Data

Pre-Check before Dirty-Up:

parameter		unit		4000rpm FL			2000rpm FL		
				value	lower limit	upper limit	value	lower limit	upper limit
speed			1/min	3998,9	3995	4005	1999,3	1995	2005
torque			Nm	234,8	227	250	316,2	305	335
blowby			l/min	64,0			65,4		
coolant			°C	98,2	95	99	97,9	95	99
coolant flow	inner circuit		l/min	125,4	120	130	62,3		
coolant flow	EGR circuit		l/min	32,3	30	40	16,4		
boost air	after IC		°C	50,0	47	53	50,0		
exh	pre turbo		°C	662,5		780	585,8		
fuel	pre HPP		°C	33,9	30	34	29,6		
oil galery	engine inlet		°C	127,5		136	122,5		
oil pressure		gauge	bar	4,0	3		2,4		
intake air	air filter	gauge	mbar	-25,2	-70		0,6		
exh	after turbo	gauge	mbar	425,9	410	450	116,5		
boost pressure	after IC	absolute	mbar	2187,8	2100	2300	2308,6		
fuel	pre HPP	gauage	mbar	-70,0	-300	0	-69,9		
fuel	injector return	gauage	mbar	1165,0	700		760,5		
fuel	HPP return	gauage	mbar	5,7		800	7,4		
i_tia			°C	24,0	20	30	23,9	20	30
i_tco			°C	97,0	95	99	97,0	95	99
i_mf_tot			mg/strk	50,6	50	51	62,0		
i_map_sp_mmv			hPa	2198,5	2190	2210	2320,0		
i_map_mmv			hPa	2199,4	2190	2210	2317,3		
imaf_sp_mmv_			mg/strk	1014,9	960		1133,6		
i_maf_mmv			mg/strk	1016,3	960		1132,6		
i_fup			MPa	159,8	159	161	135,1		
i_fup_dif			MPa	0,1	-1	1	0,2		

Operational data obtained for stage 12 (operating point for evaluation of power change; full load at 4000 min⁻¹ according to test procedure) of the **Dirty-Up** coking cycle:

Dirty-Up	average	standard deviation	minimum	maximum	limits
Coolant temperature, engine outlet [°C]	97,0	0,0	97,0	97,1	97±2
Coolant flow main (inner) circuit [l/min]	125,3	0,1	125,1	125,4	125±5
Lubricant temperature [°C]	125,8	0,3	125,2	126,5	max. 136
Fuel temperature at HP pump inlet [°C]	32,0	0,1	31,9	32,4	32±2
Air temperature, Intercooler outlet [°C]	50,0	0,0	49,9	50,1	50±3
Intake air temperature [°C]	23,2	0,3	22,6	24,1	23±5
Fuel pressure at HPP inlet [mbar]	-80,0	0,2	-80,9	-79,9	-150±150
Fuel pressure at HPP return [mbar]	29,2	13,5	13,1	53,5	max. 800
Fuel pressure at HPP injector return [mbar]	1145,9	5,2	1135,3	1158,3	min. 700
Fuel rail pressure (ECU) [MPa]	159,8	0,2	159,4	160,1	160±2
Boost pressure after IC (absolute) [mbar]	2198,5	3,8	2189,5	2204,5	2200±100
Total fuel flow set point from ECU [mg/Strk]	50,6	0,0	50,5	50,6	50±0,5
Pilot injection [µs]	0,0	0,0	0,0	0,0	0,0

Operational data obtained for stage 12 (operating point for evaluation of power change; full load at 4000 min⁻¹ according to test procedure) of the **Clean-Up** coking cycle:

Clean-Up	average	standard deviation	minimum	maximum	limits
Coolant temperature, engine outlet [°C]	97,0	0,1	97,0	97,9	97±2
Coolant flow main (inner) circuit [l/min]	125,1	0,1	124,9	125,4	125±5
Lubricant temperature [°C]	126,5	0,2	125,4	126,8	max. 136
Fuel temperature at HP pump inlet [°C]	32,1	0,2	31,8	32,5	32±2
Air temperature, Intercooler outlet [°C]	50,0	0,0	49,9	50,1	50±3
Intake air temperature [°C]	23,2	0,3	22,8	23,9	23±5
Fuel pressure at HPP inlet [mbar]	-80,0	0,0	-80,1	-80,0	-150±150
Fuel pressure at HPP return [mbar]	32,5	7,4	21,2	44,5	max. 800
Fuel pressure at HPP injector return [mbar]	1128,8	8,8	1115,1	1144,4	min. 700
Fuel rail pressure (ECU) [MPa]	159,9	0,2	159,4	160,3	160±2
Boost pressure after IC (absolute) [mbar]	2199,2	2,7	2193,9	2205,8	2200±100
Total fuel flow set point from ECU [mg/Strk]	50,6	0,0	50,5	50,6	50±0,5
Pilot injection [µs]	0,0	0,0	0,0	0,0	0,0

*Metal content of the **Dirty-Up** test fuel according ASTM D7111:*

The measurement is optional and is performed for reference tests only.

Instances of operations outside specific limits and unusual occurrences:

- None.

1 Test Evaluation

1.1 Dirty-Up (DU) Test

The level of injector coking is characterised by measuring the observed rated power from the beginning of the test to the end. The power at the start of the test is estimated by fitting a linear regression line to the first five measurements (0-4) and extrapolating the fitted regression line back to time zero. Similarly the power at the end of the test is estimated by fitting a linear regression line to the last five measurements.

Calculated power loss between start and end of the dirt-up test in percentage according to

CEC F-98-08 Section 08.1:

test result evaluation Dirty-Up	fitted observed rated power kW	change of fitted observed rated power %
SoT (0h)	96,39	0,00
8h	95,07	-1,37
16h	93,67	-2,83
24h	92,96	-3,55
EoT (32h) coking	91,56	-5,01

Negative values corresponding to a power loss and positive values to a power gain

Running time in coking cycle with the dirty-up test fuel: 32 h

1.2 Clean-Up (CU) Test

The power at the start of the clean-up test is estimated by fitting a linear regression line to the first five measurements (coking cycle 32-36) and extrapolating the fitted regression line back to cycle 32. Similarly the power at the end of the test is estimated by fitting a linear regression line to the last five measurements and taking the fitted value after the last 64th cycle.

test result evaluation Clean-Up	fitted observed rated power kW	change of fitted observed rated power %
SoT (32h)	92,90	0,00
40h	96,96	4,37
48h	97,33	4,77
56h	97,44	4,88
EoT (64h) coking	97,43	4,87

Negative values corresponding to a power loss and positive values to a power gain

Running time in coking cycle with the clean-up test fuel: 32 h

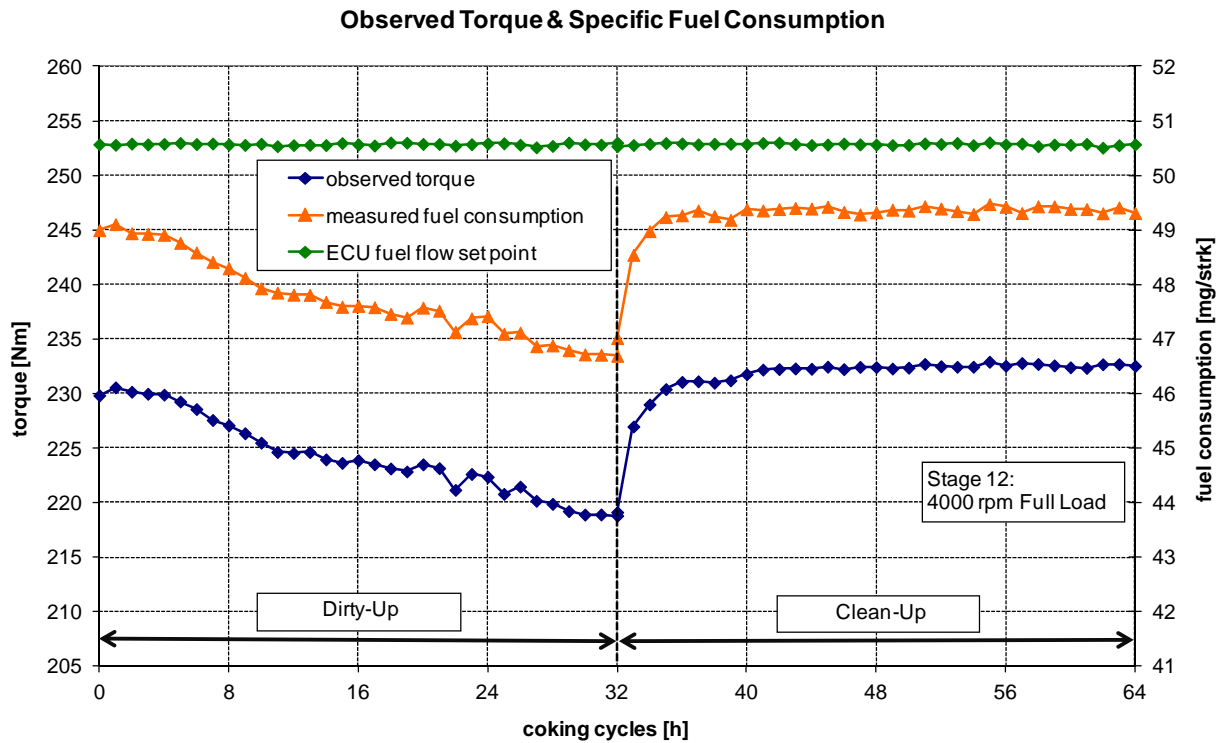
1.3 Dirty-Up and Clean-Up Test combined

test result evaluation Dirty-Up and Clean-Up Combined	fitted observed rated power kW	change of fitted observed rated power %
SoT (0h)	96,39	0,00
32h	91,56	-5,01
EoT (64h) coking	97,43	1,08

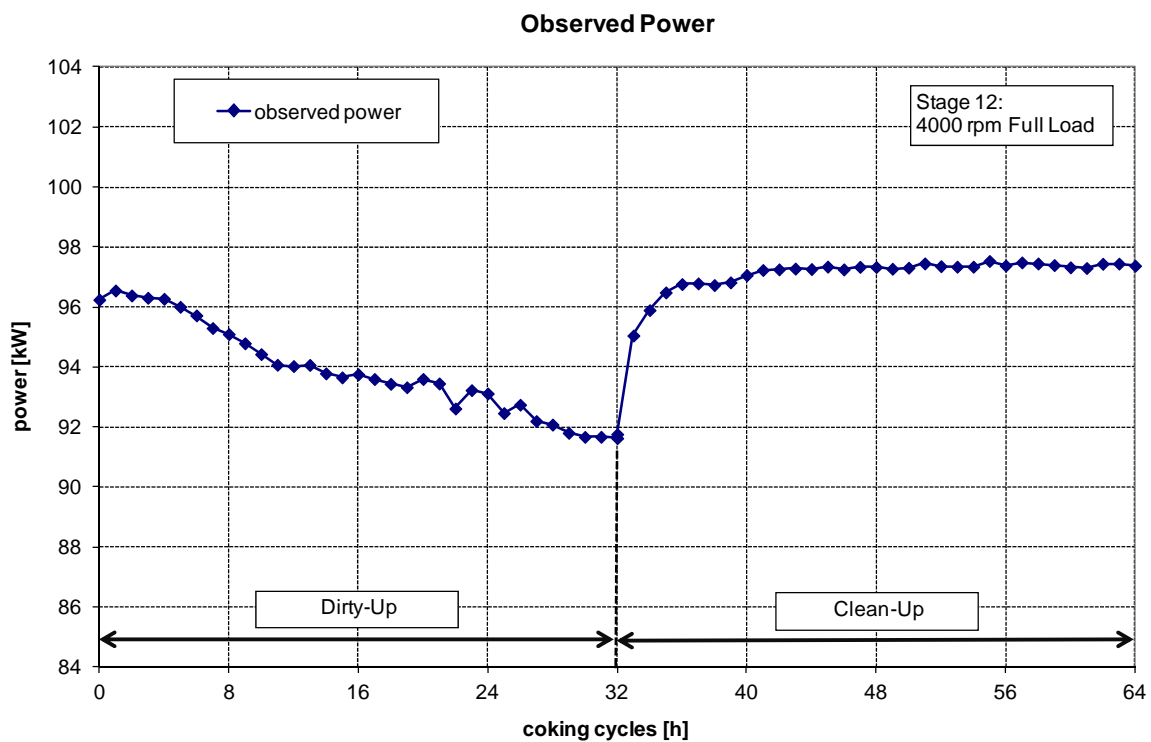
Negative values corresponding to a power loss and positive values to a power gain

Total oil consumption (dirty-up test run)	168	gram
Total oil consumption (clean-up test run)	165	gram
Blowby at 4000min ⁻¹ full load at SoT	64,0	l/min
Coolant flow EGR/heater at 4000min ⁻¹ full load at SoT	32,3	l/min
Engine run time at SoT	157	h
DTC test bench no	110	

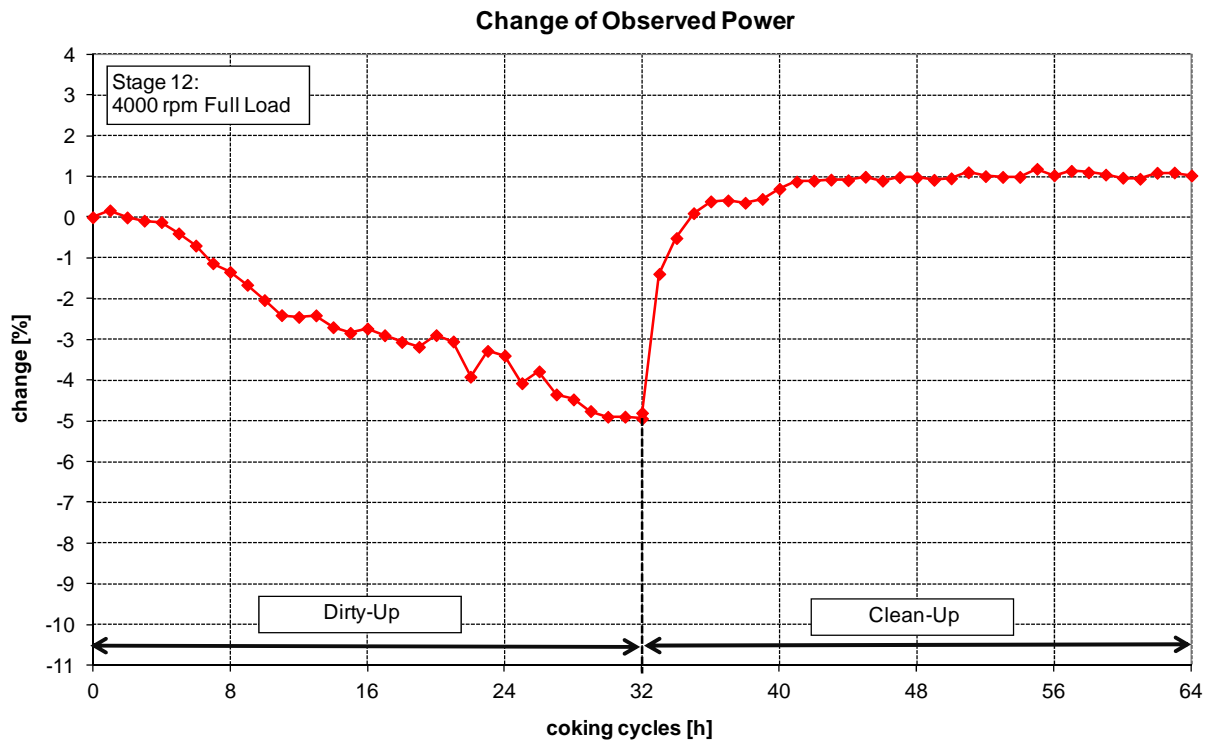
Measured specific fuel consumption versus ECU fuel flow set point and measured torque profile of stage 12 during test procedure:



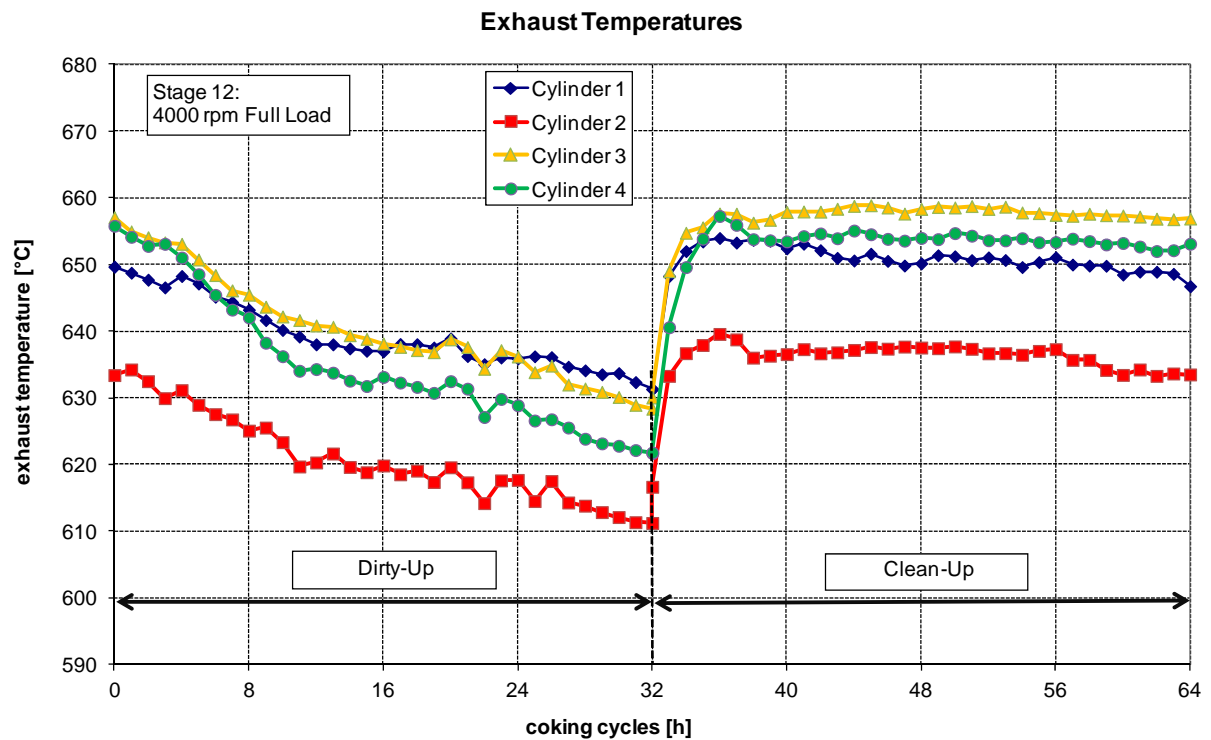
Observed power of stage 12 during test procedure:



Change of observed power of stage 12 during test procedure:



Exhaust temperatures of stage 12 during test procedure:



Test results of stage 12 during **Dirty-Up** test procedure:

Dirty-Up Cycle	speed	observed torque	observed power	fitted power acc. CEC	change of observed power	fuel consumption set point	fuel consumption measured	fitted fuel cons.	change of observed fuel cons.
-	1/min	Nm	kW	kW	%	mg/strk	mg/strk	mg/strk	%
0	3999	229,8	96,24	96,39	0,00	50,57	48,99	49,04	0,00
1	3999	230,6	96,55		0,17	50,56	49,11		0,12
2	3999	230,2	96,38		-0,01	50,58	48,94		-0,21
3	3999	230,0	96,31		-0,09	50,57	48,93		-0,24
4	3999	229,9	96,27		-0,12	50,58	48,91		-0,27
5	3999	229,3	96,01		-0,40	50,59	48,76		-0,57
6	3999	228,6	95,72		-0,70	50,57	48,59		-0,93
7	3999	227,6	95,30		-1,13	50,58	48,41		-1,29
8	3999	227,1	95,10	95,07	-1,34	50,57	48,30	48,28	-1,52
9	3999	226,4	94,79		-1,66	50,56	48,12		-1,88
10	3999	225,5	94,43		-2,03	50,58	47,93		-2,27
11	3999	224,6	94,07		-2,40	50,54	47,85		-2,43
12	3999	224,5	94,03		-2,45	50,56	47,81		-2,51
13	3999	224,6	94,07		-2,41	50,56	47,81		-2,52
14	3999	224,0	93,79		-2,70	50,56	47,68		-2,78
15	3999	223,6	93,65		-2,84	50,59	47,59		-2,96
16	3999	223,9	93,76	93,67	-2,73	50,57	47,61	47,57	-2,93
17	3999	223,5	93,60		-2,90	50,55	47,58		-2,98
18	3999	223,1	93,44		-3,06	50,60	47,46		-3,23
19	3999	222,9	93,32		-3,18	50,60	47,39		-3,37
20	3999	223,5	93,60		-2,89	50,58	47,57		-3,00
21	3999	223,2	93,45		-3,05	50,58	47,52		-3,11
22	3999	221,2	92,62		-3,92	50,54	47,13		-3,90
23	3999	222,6	93,23		-3,28	50,57	47,38		-3,40
24	3999	222,4	93,12	92,96	-3,40	50,59	47,42	47,31	-3,31
25	3999	220,8	92,46		-4,07	50,59	47,10		-3,97
26	3999	221,5	92,74		-3,78	50,56	47,12		-3,93
27	3999	220,2	92,20		-4,35	50,51	46,87		-4,44
28	3999	219,9	92,08		-4,47	50,54	46,88		-4,41
29	3999	219,2	91,80		-4,76	50,60	46,79		-4,59
30	3999	218,9	91,67		-4,90	50,57	46,72		-4,75
31	3999	218,9	91,67		-4,90	50,56	46,71		-4,76
32	3999	218,8	91,63	91,56	-4,94	50,60	46,69	46,67	-4,80
				EoT fitted DU	-5,01			EoT fitted DU	-4,85

Test results of stage 12 during **Clean-Up** test procedure:

Clean-Up Cycle	speed	observed torque	observed power	fitted power acc. CEC	change of observed power	fuel consumption set point	fuel consumption measured	fitted fuel cons.	change of observed fuel cons.
-	1/min	Nm	kW	kW	%	mg/strk	mg/strk	mg/strk	%
32	3999	219,1	91,76	92,90	-4,80	50,54	47,02	47,02	-4,13
33	3999	227,0	95,05		-1,39	50,56	48,54		-1,02
34	3999	229,0	95,90		-0,51	50,58	48,98		-0,14
35	3999	230,4	96,49		0,10	50,59	49,24		0,39
36	3999	231,1	96,76		0,39	50,59	49,27		0,45
37	3999	231,1	96,79		0,41	50,57	49,35		0,63
38	3999	231,0	96,73		0,35	50,58	49,25		0,43
39	3999	231,2	96,82		0,45	50,58	49,18		0,29
40	3999	231,8	97,06	96,96	0,70	50,57	49,38	49,30	0,68
41	3999	232,2	97,23		0,88	50,59	49,36		0,63
42	3999	232,2	97,25		0,90	50,60	49,38		0,69
43	3999	232,3	97,28		0,92	50,57	49,40		0,73
44	3999	232,3	97,27		0,91	50,56	49,39		0,71
45	3999	232,5	97,35		0,99	50,57	49,42		0,77
46	3999	232,2	97,25		0,90	50,58	49,33		0,58
47	3999	232,4	97,34		0,98	50,57	49,28		0,49
48	3999	232,4	97,33	97,33	0,98	50,57	49,32	49,30	0,57
49	3999	232,3	97,27		0,92	50,56	49,37		0,67
50	3999	232,4	97,31		0,95	50,56	49,35		0,63
51	3999	232,7	97,45		1,10	50,59	49,43		0,79
52	3999	232,5	97,36		1,01	50,58	49,39		0,71
53	3999	232,5	97,34		0,99	50,60	49,34		0,61
54	3999	232,5	97,34		0,99	50,55	49,29		0,51
55	3999	232,9	97,53		1,19	50,61	49,47		0,87
56	3999	232,5	97,38	97,44	1,03	50,57	49,42	49,42	0,77
57	3999	232,8	97,49		1,14	50,58	49,31		0,54
58	3999	232,7	97,45		1,10	50,54	49,43		0,79
59	3999	232,6	97,40		1,05	50,57	49,43		0,79
60	3999	232,4	97,32		0,97	50,56	49,38		0,69
61	3999	232,3	97,30		0,94	50,58	49,38		0,69
62	3999	232,7	97,44		1,09	50,51	49,30		0,53
63	3999	232,7	97,45		1,10	50,55	49,41		0,75
64	3999	232,5	97,38	97,43	1,02	50,57	49,31	49,33	0,54
				EoT fitted CU	4,87			EoT fitted CU	4,93
				EoT fitted combined	1,08			EoT fitted combined	0,59