Beilage ./5

SGS Drive Technology Center

SGS Report No.	201927
Order No.	15-21-210980C
SGS Test No.	[redacted]
Customer Order No.	4563221

This report replaces the report no. 201919 of SGS Austria, issued on 21.01.2016.

Report

Dirty-Up und Clean-Up Direct Injection, Common Rail Diesel Engine Nozzle Coking Test based on CEC F-98-08 with the PSA DW10B engine, including „Add On FC Measurement" according to method description for EEffG in Austria

26.01.2016

SGS Austria Controll-Co. Ges.m.b.H.
Drive Technology Center
Mannswörther Str. 28
A-2320 Schwechat

Drive Technology Center

[redacted]

SGS Austria Controll-Co. Ges.m.b.H
Oil, Gas & Chemical Services
Drive Technology Center
Mannswörther Straße 28
A – 2320 Schwechat

Test no.	[redacted]
Receipt of Test Fuel	04.10.2015
Start of Test	05.10.2015
End of Test	16.10.2015
Engine no.	0565109 (Referenz Nr. 10WAG6)
Engine runtime at Start of Test	194 h
Test Fuel Code	**RF-79-07/8 + 1mg/kg Zn** (Dirty-Up) **RF-79-07/8 +** [redacted] **mg/kg** [redacted] (Clean-Up) Fuel from Haltermann. The additive and zinc was added by SGS.
Test Fuel ID	20155566 (DU), 20155567 (CU)
Test Injectors ID	1. Zylinder: Laufzeit vor Teststart: 194 h 2. Zylinder: Laufzeit vor Teststart: 194 h 3. Zylinder: Laufzeit vor Teststart: 194 h 4. Zylinder: Laufzeit vor Teststart: 194 h
Test Oil Used	RL 236 / Batch 4
Test Procedure*	Test procedure according to EEffG method in Austria*
Comment	Used, but cleaned injectors were used
Test Validity	**valid**
Test Result*	Change of measured fuel consumption in percentage after 32 h: **2,3 %*** **A change of fuel consumption from 3,2 % to 0,9 % using additive type** [redacted] **at a treat rate of** [redacted] **mg/kg was observed.***
Date of last Accreditation	12.11.2014

Schwechat, 26.01.2016

Dr. Christian Strasser
Lab Manager

DI Thomas Feitzinger
Project Manager

* = Test Method not accredited: Test is not in accordance with CEC test (CEC F-98-08), because the run time is extended and the additional fuel consumption measurements (Add On FC) are performed.

(1) = Analysis performed in other accredited laboratory
(2) = Analysis performed in other not accredited laboratory

1 Test Procedure

Task of the tests is the verification of an additive according to the existing method description, corresponding to the Austrian Energy Efficiency Law for diesel fuels. The overall sequence of the recommended test procedure inclusive handling of the operating materials can be seen in Figure 1 and Figure 2. In Figure 1 the Dirty-Up and in Figure 2 the Clean-Up cycle is described.

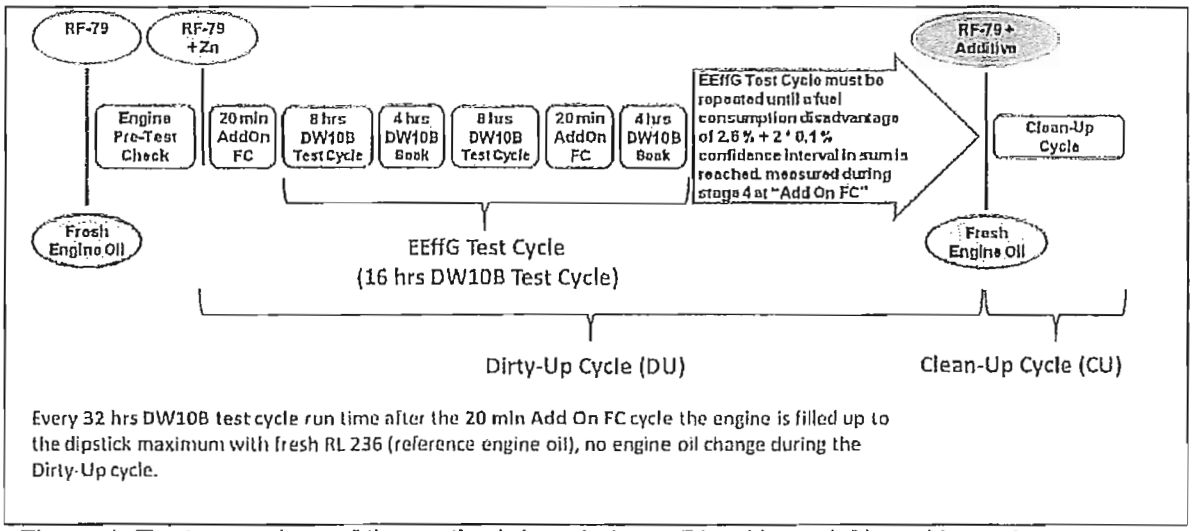


Figure 1: Test procedure of the method description – Dirty-Up and Clean-Up cycle

The duration for the Clean-Up cycle results out of the time which is necessary for reaching more than 50 % of the sum of 2,6 % fuel consumption improvement + 2 * 0,1 % confidence interval. The minimum duration for the Clean-Up cycle is in total at least 32 hours. Figure 2 shows the details during the Clean-Up cycle.

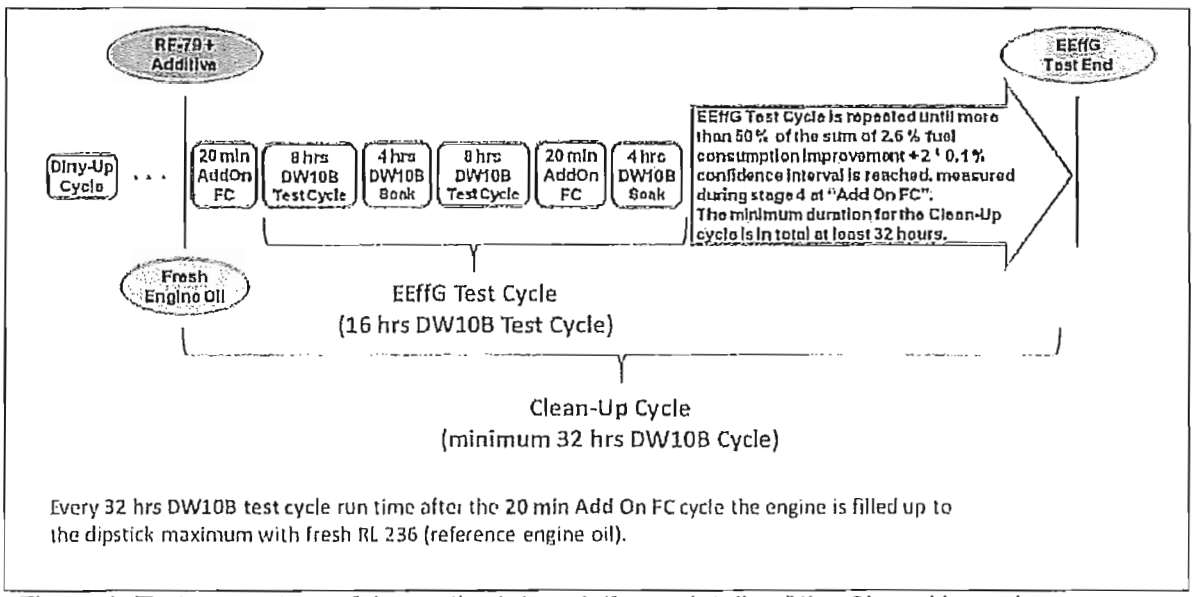


Figure 2: Test procedure of the method description – details of the Clean-Up cycle

Before and during the test cycle reference measurements in terms of a fuel consumption measurement cycle are performed.
These measurements consist of 3 single measurements, which are averaged over 2 minutes. The mean value of these three single measurements results in the detected fuel consumption:

- fuel consumption measurement cycle at stage 4 (20 min):
  - 11 min stabilization
  - 3 x „Add On FC" measurement (single measurements)
    - 2 min measurement
    - 1 min holding time

2 Evaluation of Confidence Interval

The evaluation of the confidence interval is described in the document "Methodenempfehlung für EEffG von SGS DTC". A confidence interval of 0,1 % is given for the test.

3 Unusual Occurrences

none

4 Instances of operations outside specific limits

none

5 Brake Specific Fuel Consumption (BSFC) during "Add On FC"

BSFC and change of BSFC in percentage during fuel consumption measurement cycle ("Add On FC") of the overall result:

	runtime	BSFC	Change of BSFC*
	[h]	[g/kWh]	[%]
SoT	0	219,7	0,0
EoT - DU	128	226,7	3,2
EoT - CU	160	221,5	0,9
Real Value =	Δ BSFC$_{CU}$ - Δ BSFC$_{DU}$ =		**2,3**
Target >	50% v. (2,6 % + 2 x confidence interval) =		**1,4****

SoT... Result at Start of Dirty-Up Phase

EoT- DU... Result at End of Dirty-Up Phase

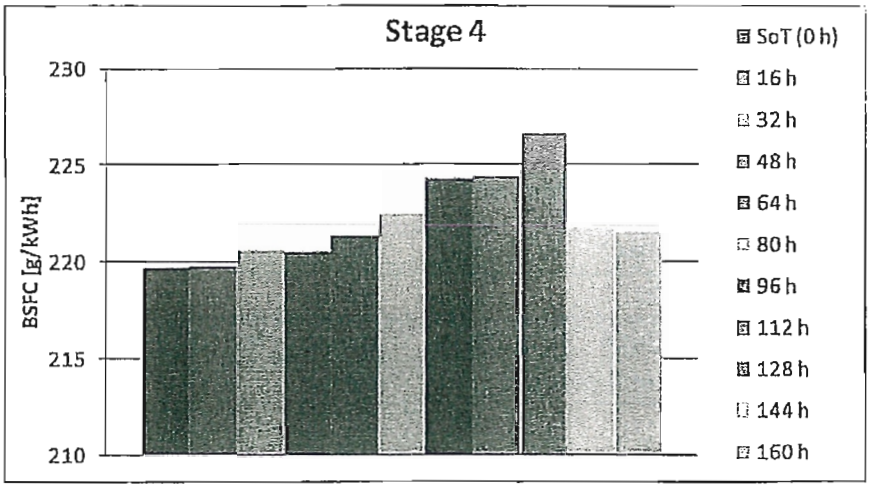
EoT- CU... Result at End of Clean-Up Phase

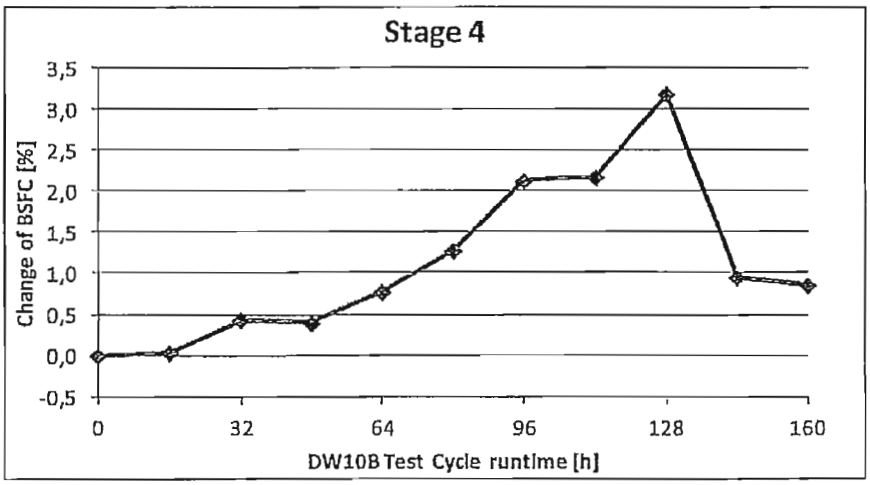
*... Change of brake specific fuel consumption (BSFC) referred to the BSFC at the beginning of the Dirty-Up phase in percentage.

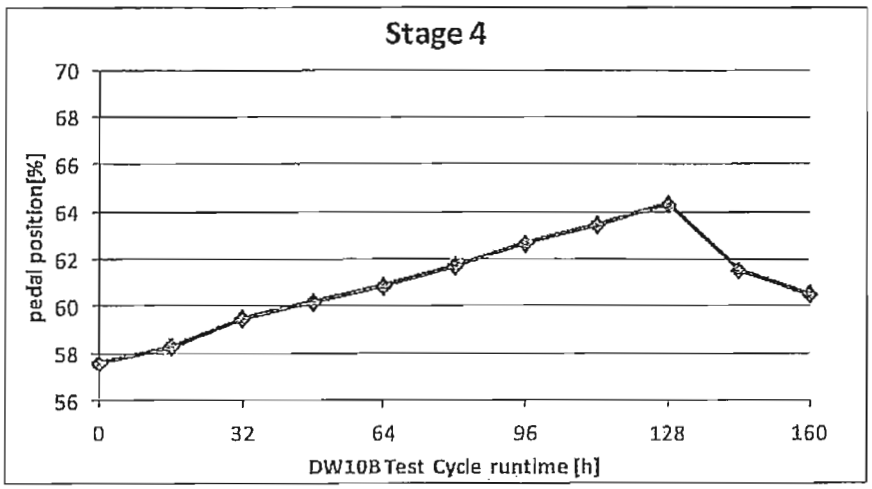
**... As described in detail in the EEffG method description (Umsetzung/Anerkennung der Energieeffizienzmaßnahmen für Dieselkraftstoffe im Rahmen des EEffG mittels Additiven in Österreich, Juni 2015) for Austria, a change of fuel consumption greater than 1,4 % must be achieved by clean up effect within at least 32 h.

A change of fuel consumption from 3,2 % to 0,9 % using additive type [redacted] at a treat rate of [redacted] **mg/kg** was observed.

BSFC and change of BSFC in percentage during fuel consumption measurement cycle ("Add On FC") and the pedal value during runtime:







6 Operational Data

6.1 Operational Data at Pre-Check

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	241,7	*227*	*250*	323,7	*305*	*335*
blowby			l/min	56,8			56,8		
coolant			°C	97,0	*95*	*99*	97,0	*95*	*99*
coolant flow	inner circuit		l/min	126,8	*120*	*130*	63,9		
coolant flow	EGR circuit		l/min	33,3	*30*	*40*	14,9		
boost air	after IC		°C	50,1	*47*	*53*	49,9		
exh	pre turbo		°C	742,2		*780*	669,6		
fuel	pre HPP		°C	32,8	*30*	*34*	31,5		
oil gallery	engine inlet		°C	131,9		*136*	124,7		
oil pressure		gauge	bar	4,0	*3*		2,3		
intake air	air filter	gauge	mbar	-40,1	*-80*		-6,3		
exh	after turbo	gauge	mbar	434,5	*410*	*450*	114,2		
boost pressure	after IC	absolute	mbar	2209,6	*2100*	*2300*	2333,8		
fuel	pre HPP	gauage	mbar	-70,1	*-300*	*0*	1,5		
fuel	injector return	gauage	mbar	1090,4	*700*		747,6		
fuel	HPP return	gauage	mbar	292,2		*800*	177,3		
i_tia			°C	24,7	*20*	*30*	25,8	*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	2198,3	*2190*	*2210*	2319,6		
i_map_mmv			hPa	2194,9	*2190*	*2210*	2320,2		
imaf_sp_mmv			mg/strk	1018,3	*960*		1153,9		
i_maf_mmv			mg/strk	1019,3	*960*		1154,0		
i_fup			MPa	159,7	*159*	*161*	134,9		
i_fup_dif			MPa	0,2	*-1*	*1*	0,3		

6.2 Operational Data during Stage 12

Dirty-Up	average	standard deviation	minimum	maximum	*limits*
Coolant temperature, engine outlet [°C]	97,0	0,0	97,0	97,1	*97±2*
Lubricant temperature [°C]	129,8	0,7	128,8	131,3	*max.136*
Fuel temperature at HP pump inlet [°C]	32,4	0,2	32,0	32,9	*32±2*
Air temperature, Intercooler outlet [°C]	50,0	0,1	49,7	50,2	*50±3*
Intake air temperature [°C]	22,5	0,8	21,4	24,2	*23±5*
Fuel pressure at HPP inlet [mbar]	-80,0	0,4	-81,5	-79,0	*-150±150*
Fuel pressure at HPP injector return [mbar]	1075,3	22,6	1029,1	1118,6	*min. 700*
Fuel rail pressure (ECU) [MPa]	159,8	0,1	159,6	160,0	*160±2*
Boost pressure after IC (absolute) [mbar]	2198,5	0,2	2197,7	2199,0	*2200±15*
Total fuel flow set point from ECU [mg/Strk]	50,5	0,0	50,5	50,6	*50±0,5*
Pilot injection [µs]	0,0	0,0	0,0	0,0	*0,0*

Clean-Up	average	standard deviation	minimum	maximum	*limits*
Coolant temperature, engine outlet [°C]	97,0	0,0	97,0	97,0	*97±2*
Lubricant temperature [°C]	128,9	0,3	128,2	129,4	*max.136*
Fuel temperature at HP pump inlet [°C]	32,4	0,1	32,3	32,5	*32±2*
Air temperature, Intercooler outlet [°C]	50,0	0,2	49,7	50,4	*50±3*
Intake air temperature [°C]	22,2	0,8	21,4	23,9	*23±5*
Fuel pressure at HPP inlet [mbar]	-80,0	0,3	-80,6	-79,6	*-150±150*
Fuel pressure at HPP injector return [mbar]	1058,4	17,0	1028,8	1087,4	*min. 700*
Fuel rail pressure (ECU) [MPa]	159,8	0,1	159,6	160,0	*160±2*
Boost pressure after IC (absolute) [mbar]	2198,5	0,3	2197,8	2198,9	*2200±15*
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*

6.3 Operational Data during Stage 4

Dirty-Up	average	standard deviation	minimum	maximum	*limits*
Coolant temperature, engine outlet [°C]	97,0	0,0	97,0	97,1	*97±2*
Fuel temperature at HP pump inlet [°C]	32,3	0,1	32,1	32,5	*32±2*
Air temperature, Intercooler outlet [°C]	50,0	0,1	49,8	50,2	*50±3*
Intake air temperature [°C]	22,9	1,0	21,3	24,7	*23±5*
Engine speed [1/min]	3499,0	0,0	3499,0	3499,0	*3500±10*
Engine torque [Nm]	212,0	0,2	211,7	212,3	*212±6*

Clean-Up	average	standard deviation	minimum	maximum	*limits*
Coolant temperature, engine outlet [°C]	97,0	0,0	97,0	97,0	*97±2*
Fuel temperature at HP pump inlet [°C]	32,2	0,1	32,1	32,3	*32±2*
Air temperature, Intercooler outlet [°C]	50,0	0,1	49,9	50,1	*50±3*
Intake air temperature [°C]	23,2	1,1	21,6	24,6	*23±5*
Engine speed [1/min]	3499,0	0,0	3499,0	3499,0	*3500±10*
Engine torque [Nm]	212,0	0,2	211,6	212,3	*212±6*