

# 25DN-072 Test Project Report

for

**WorldKlass Technologies Corporation**



**September 30, 2016**

**Test conducted by**

**Dr. Kim Kangwook**



**NYC Department of Sanitation**

<b><u>PROJECT</u></b>		<b>WorldKlass</b>		
Vehicle	DSNY ID	25DN-072		
	Model Year	2015		
	Miles	2,060		
	Engine Hrs.	321		
	VIN #	1M2AU02C5GM009968		
Chassis	Manufacturer	Mack LE		
	Body Type	Rear Loader		
	GVW ( <i>lb.</i> )	72,000		
	Net Weight (41,000 <i>lbs.</i> )	Left Front	Right Front	
		6,600	6,200	
		7,500	6,600	
		7,000	7,100	
Tire Radius ( <i>in.</i> )	21 <i>in.</i> (533 <i>mm</i> )			
# of Axle	3			
Engine	Manufacturer	Mack		
	Engine Year	2015		
	Model #	MP7-325M		
	Family #	FVPTH10.8G01		
	Serial #	573670		
	Size ( <i>ℓ</i> )	10.8		
	Horsepower	325		
	Emi. Compliance	2015		
	Transmission	Allison		
After-Treatment	Manufacturer	OEM		
	Application	PDPF + SCR		

# Vehicle Information

## (1) Engine Family

**IMPORTANT ENGINE INFORMATION** MACK TRUCKS, INC. **VALVE LASH (JEU SOUPAPES)**

**RENSEIGNEMENTS IMPORTANTS MOTEUR**

ENGINE FAMILY: FVPTH10.8G01 ENGINE MODEL: MP7-325M SERIAL NO.: 573670  
 FAMILLE DE MOTEURS: MODELE MOTEUR: NO. SERIE:

DISPLACEMENT ADVERTISED HP @ RPM FUEL RATE @ ADVERTISED HP IDLE SPEED ENGINE BRAKE  
 CYLINDREE PUISS. SPEC. @ TOURS/MIN. DEBIT DE CARB. @ PUISS. SPEC. RALENTI FREIN MOTEUR  
 10.8L 325/1900 186 mm<sup>3</sup> / STROKE 550-700 RPM  
 mm<sup>3</sup> / COUP

THIS ENGINE CONFORMS TO U.S. EPA AND CALIFORNIA REGULATIONS APPLICABLE TO 2015 MODEL YEAR NEW HEAVY-DUTY ENGINES AND HAS A PRIMARY INTENDED SERVICE APPLICATION AS A HEAVY HEAVY-DUTY DIESEL ENGINE.

Ce moteur est conforme aux réglementations de Californie et de l'Agence de Protection de l'Environnement des Etats-Unis applicables aux nouveaux moteurs diesel Heavy duty (Gamme lourde) modèle 2015. La principale application s'adresse aux usages de type gamme lourde (Heavy-heavy-duty).

EXHAUST EMISSIONS CONTROL SYSTEM THIS ENGINE IS CERTIFIED TO OPERATE ON  
 DISPOSITIF ANTI-POLLUTION: ULTRA LOW SULFUR DIESEL FUEL ONLY

TC, CAC, EGR, DDI, ECM, DOC, PTOX, SCR, AMOX

LABEL NO  
 225136441

**COMPLETE VEHICLE MFD.** MACK DATE 5/7/2015

**VEHICLE TYPE CLASSIFICATION** VEHICLE ID # 1M2AU02C5GM009968

KG	WI	315/80R22.5	ON	22.5 x 9.0	RIMS @	130	PSI/LPC	900	KPA
KG	WI	315/80R22.5	ON	22.5 x 9.0	RIMS @	130	PSI/LPC	900	KPA
KG	WI		ON		RIMS @		PSI/LPC		KPA
KG	WI		ON		RIMS @		PSI/LPC		KPA
KG	WI		ON		RIMS @		PSI/LPC		KPA
37 KG	WI	315/80R22.5	ON	22.5 x 9.0	RIMS @	130	PSI/LPC	900	KPA

NO FEDERAL MOTOR VEHICLE SAFETY STANDARDS WHICH HAVE BEEN PREVIOUSLY FULLY  
 MANUFACTURE OR BY THE INTERMEDIATE VEHICLE MANUFACTURE HAS NOT BEEN  
 MANUFACTURE. THE VEHICLE HAS BEEN COMPLETED IN ACCORDINANCE WITH THE PRIOR  
 STANDARDS APPLICABLE. THIS VEHICLE CONFORMS TO ALL OTHER SAFETY STANDARDS IN EFFECT IN: YR. 2015

MO. Aug

## (2) Engine & Technology Application

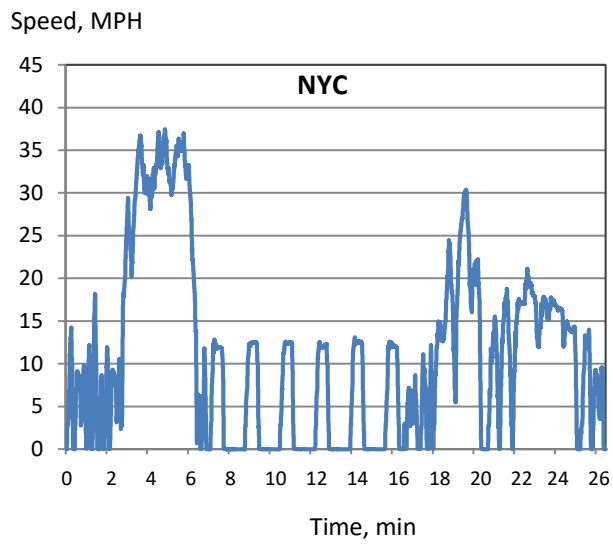


### (3) Vehicle on Dynamometer

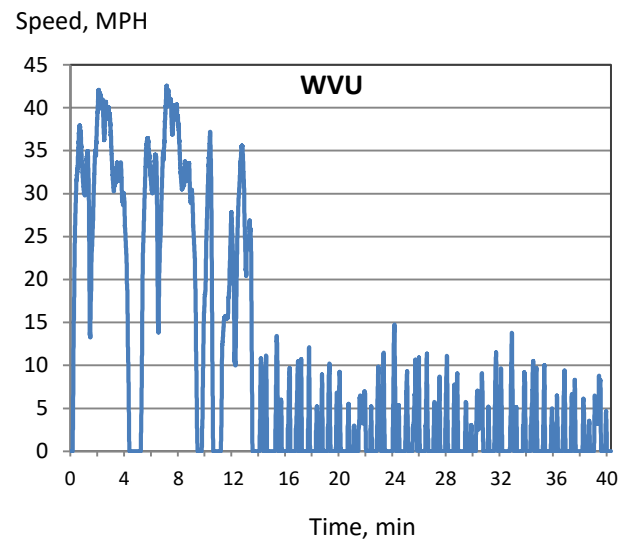


## Test Protocols

### (1) NYC Test Cycle



### (2) WVU Test Cycle



# Test Results

## 25DN-072 NYC Test Cycle

### (1) Baseline (Dec. 4, 2015)

Test #	Report Number	THC (g/mi)	CO (g/mi)	NO <sub>x</sub> (g/mi)	CO <sub>2</sub> (kg/mi)	CH <sub>4</sub> (g/mi)	NMHC (g/mi)	F.E. (mpg)
Test I	1426	0.016	0.009	1.31	3.15	0.001	0.015	3.23
Test II	1428	0.006	0.000	2.09	3.09	0.001	0.014	3.30
Test III	1430	0.003	0.009	2.52	3.06	0.001	-	3.32
AVG.		0.008	0.006	1.98	3.10	0.001	0.010	3.28

### (2) WorldKlass (Dec. 8, 2015) (Device installed on Dec. 7, 2015)

Test #	Report Number	THC (g/mi)	CO (g/mi)	NO <sub>x</sub> (g/mi)	CO <sub>2</sub> (kg/mi)	CH <sub>4</sub> (g/mi)	NMHC (g/mi)	F.E. (mpg)
Test I	1436	0.017	0.020	1.04	3.15	0.001	0.014	3.23
Test II	1440	0.009	0.104	5.82	3.18	0.002	0.017	3.20
Test III	1442	0.008	0.006	3.61	3.09	0.001	0.017	3.29
AVG.		0.011	0.043	3.49	3.14	0.001	0.016	3.24

### (3) WorldKlass (Sep. 8, 2016) (Device installed on Dec. 7, 2015)

Test #	Report Number	THC (g/mi)	CO (g/mi)	NO <sub>x</sub> (g/mi)	CO <sub>2</sub> (kg/mi)	CH <sub>4</sub> (g/mi)	NMHC (g/mi)	F.E. (mpg)
Test I	1607	0.013	0.137	2.97	2.96	-	0.017	3.44
Test II	1608	0.006	0.109	3.40	2.99	0.001	0.014	3.40
Test III	1610	0.010	0.152	6.21	2.98	-	0.019	3.41
Test IV	1617	0.010	0.124	5.26	2.97	-	0.027	3.42
AVG.		0.010	0.131	4.46	2.98	0.000	0.019	3.42

### (4) Baseline (Sep. 15, 2016) (Device removed on Sep. 13, 2016)

Test #	Report Number	THC (g/mi)	CO (g/mi)	NO <sub>x</sub> (g/mi)	CO <sub>2</sub> (kg/mi)	CH <sub>4</sub> (g/mi)	NMHC (g/mi)	F.E. (mpg)
Test I	1619	0.015	0.148	2.53	2.91	-	0.031	3.49
Test II	1621	0.009	0.123	8.18	2.97	0.002	0.023	3.42
Test III	1628	0.009	0.118	5.64	2.95	-	0.028	3.44
Test IV	1629	0.014	0.166	7.89	2.98	0.001	0.029	3.41
AVG.		0.012	0.139	6.06	2.95	0.001	0.028	3.44

### (5) Baseline (Sep. 19, 2016) (Device removed on Sep. 13, 2016)

Test #	Report Number	THC (g/mi)	CO (g/mi)	NO <sub>x</sub> (g/mi)	CO <sub>2</sub> (kg/mi)	CH <sub>4</sub> (g/mi)	NMHC (g/mi)	F.E. (mpg)
Test I	1635	0.003	0.155	7.24	3.09	0.001	0.014	3.28

## 25DN-072 WVU Test Cycle

### (1) Baseline (Dec. 4, 2015)

Test #	Report Number	THC (g/mi)	CO (g/mi)	NO <sub>x</sub> (g/mi)	CO <sub>2</sub> (kg/mi)	CH <sub>4</sub> (g/mi)	NMHC (g/mi)	F.E. (mpg)
Test I	1427	0.009	0.009	7.78	3.73	0.002	0.024	2.72
Test II	1431	0.011	0.032	6.35	3.73	0.002	0.025	2.73
Test III	1434	0.010	0.031	8.17	3.75	0.003	0.028	2.71
AVG.		0.010	0.024	7.43	3.74	0.002	0.026	2.72

### (2) WorldKlass (Dec. 8, 2015) (Device installed on Dec. 7, 2015)

Test #	Report Number	THC (g/mi)	CO (g/mi)	NO <sub>x</sub> (g/mi)	CO <sub>2</sub> (kg/mi)	CH <sub>4</sub> (g/mi)	NMHC (g/mi)	F.E. (mpg)
Test I	1437	0.005	0.004	9.07	3.67	0.001	0.027	2.77
Test II	1439	0.007	0.007	6.87	3.68	0.002	0.021	2.77
Test III	1441	0.009	0.002	6.60	3.69	0.002	0.022	2.76
AVG.		0.007	0.005	7.51	3.68	0.002	0.023	2.77

### (3) WorldKlass (Sep. 8, 2016) (Device installed on Dec. 7, 2015)

Test #	Report Number	THC (g/mi)	CO (g/mi)	NO <sub>x</sub> (g/mi)	CO <sub>2</sub> (kg/mi)	CH <sub>4</sub> (g/mi)	NMHC (g/mi)	F.E. (mpg)
Test I	1609	0.006	0.129	11.78	3.53	0.001	0.025	2.88
Test II	1612	0.004	0.141	12.19	3.54	0.001	0.028	2.87
Test III	1614	0.012	0.149	9.33	3.58	0.001	0.034	2.84
Test IV	1615	0.012	0.142	10.57	3.55	0.001	0.039	2.87
AVG.		0.009	0.140	10.97	3.55	0.001	0.032	2.87

### (4) Baseline (Sep. 15, 2016) (Device removed on Sep. 13, 2016)

Test #	Report Number	THC (g/mi)	CO (g/mi)	NO <sub>x</sub> (g/mi)	CO <sub>2</sub> (kg/mi)	CH <sub>4</sub> (g/mi)	NMHC (g/mi)	F.E. (mpg)
Test I	1618	0.013	0.176	13.69	3.51	0.001	0.040	2.90
Test II	1626	0.024	0.157	10.96	3.50	0.001	0.041	2.91
Test III	1627	0.015	0.150	13.00	3.53	0.001	0.037	2.89
Test IV	1630	0.012	0.156	12.49	3.57	0.001	0.041	2.85
AVG.		0.016	0.160	12.54	3.53	0.001	0.040	2.88

### (5) Baseline (Sep. 19, 2016) (Device removed on Sep. 13, 2016)

Test #	Report Number	THC (g/mi)	CO (g/mi)	NO <sub>x</sub> (g/mi)	CO <sub>2</sub> (kg/mi)	CH <sub>4</sub> (g/mi)	NMHC (g/mi)	F.E. (mpg)
Test I	1632	0.031	0.168	10.56	3.67	0.002	0.056	2.77



# DSNY: 25DN-072 Test Result Summary

## (1) NYC Test Cycle

Test Cycle	Test Condition	THC (g/mi)	CO (g/mi)	NO <sub>x</sub> (g/mi)	CO <sub>2</sub> (kg/mi)	CH <sub>4</sub> (g/mi)	NMHC (g/mi)	PM (mg/mi)	F.E. (mpg)	FE Chg. %
NYC	1	0.008	0.006	1.98	3.10	0.001	0.010	29	3.28	0.0%
	2	0.011	0.043	3.49	3.14	0.001	0.016	15	3.24	-1.2%
	3	0.010	0.131	4.46	2.98	-	0.019	19	3.42	4.3%
	4	0.012	0.139	6.06	2.95	0.001	0.028	22	3.44	4.9%
	5	0.003	0.155	7.24	3.09	0.001	0.014		3.28	0.0%

## (2) WVU Test Cycle

Test Cycle	Test Condition	THC (g/mi)	CO (g/mi)	NO <sub>x</sub> (g/mi)	CO <sub>2</sub> (kg/mi)	CH <sub>4</sub> (g/mi)	NMHC (g/mi)	PM (mg/mi)	F.E. (mpg)	Change
WVU	1	0.010	0.024	7.43	3.74	0.002	0.026	-	2.72	0.0%
	2	0.007	0.005	7.51	3.68	0.002	0.023	-	2.77	1.8%
	3	0.009	0.140	10.97	3.55	0.001	0.032	-	2.87	5.5%
	4	0.016	0.160	12.54	3.53	0.001	0.040	-	2.88	5.9%
	5	0.031	0.168	10.56	3.67	0.002	0.056		2.77	1.8%

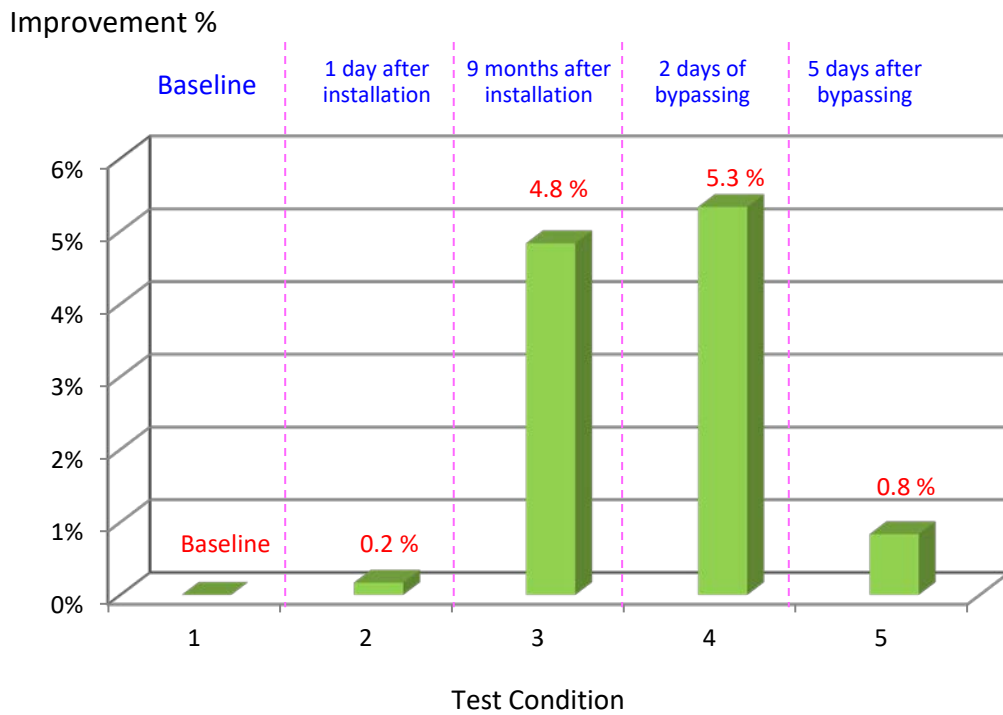
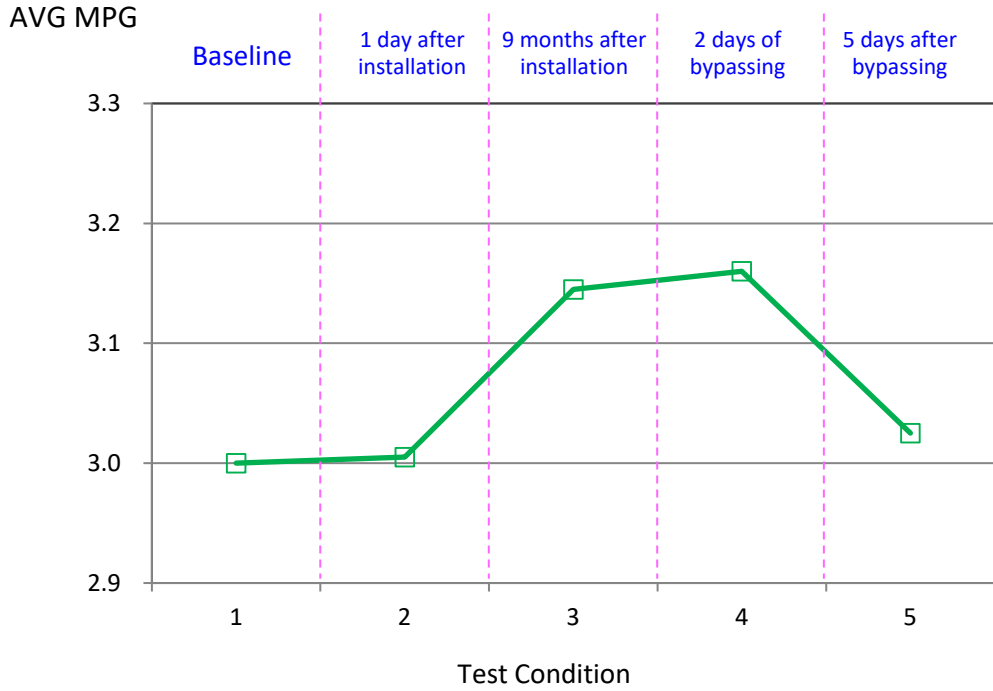
## (3) Average

Test Cycle	Test Condition	THC (g/mi)	CO (g/mi)	NO <sub>x</sub> (g/mi)	CO <sub>2</sub> (kg/mi)	CH <sub>4</sub> (g/mi)	NMHC (g/mi)	PM (mg/mi)	F.E. (mpg)	Change
AVG	1	0.009	0.015	4.705	3.42	0.002	0.018	29	3.00	0.0%
	2	0.009	0.024	5.500	3.41	0.002	0.020	15	3.01	0.2%
	3	0.010	0.136	7.715	3.27	0.001	0.026	16	3.15	4.8%
	4	0.014	0.150	9.300	3.24	0.001	0.034	22	3.16	5.3%
	5	0.017	0.162	8.900	3.38	0.002	0.035		3.03	0.8%

### Test Condition:

1. Baseline (Dec. 4, 2015).
2. WorldKlass (One day after installation of device.) (Dec. 8, 2015, device installed on Dec. 7, 2015)
3. WorldKlass (Nine months after installation of device.) (Sep. 8, 2016, device installed on Dec. 7, 2015)
4. Baseline (Two days after removing the device.) (Sep. 15, 2016, device removed on Sep. 13, 2016)
5. Baseline (Five days after removing the device.) (Sep. 19, 2016, device removed on Sep. 13, 2016)

# Graph 1. Average MPG of NYC & WVU Tests





## Graph 2. Particulate Matter (PM) Measurement in NYC Tests

Test Condition	PM (mg/mi)	Improvement	Remark
1	29	0%	Baseline
2	15	48%	1 day after installation
3	16	45%	9 mo. after installation
4	22	24%	2 days after bypassing

