



# DET NORSKE VERITAS

## INSPECTION REPORT

Report no. IND070463

This states that

At the request of DULEVO INTERNATIONAL S.p.A., the undersigned Surveyor did attend, according to below described method, aimed to inspect and collect the activities of sampling and test results for:

*Street Sweeper type DULEVO 5000*

Manufactured by

***DULEVO INTERNATIONAL S.p.A.***

***Via Giovannino Guareschi, 1 – 43012 Fontanellato (PR) - Italy***

*The DULEVO procedure used for sampling was:*

***MEASUREMENT OF FINE DUST EMISSION IN ATMOSPHERE FOR STREET SWEEPER MACHINES.***

***- ROAD TEST METHOD -***

Rev.00, 2006-06-16

Limitation

*This report is valid only for inspection activities carried out at 2007-07-06 in the town of Fidenza (PR) with machines, equipment and instruments as detailed on this report.*

*This report consists of five pages and one annex.*

Place and date

**Agrate Brianza, (MI) 2007-07-18**



# DET NORSKE VERITAS

Report no. IND070463

## Machines used to carry out tests (\*):

TYPE	SERIAL N.	YEAR	FILTER
DULEVO 5000	5000W00023/07	2007	Goretex filtering device

(\*). Further machines details are given in the test report no. 14818/2007 issued by laboratory LABORATORI INTEGRATI STUDIO ALFA S.r.l. that is part and parcel of this document.

### 1) Brief description of the test subject machine

The DULEVO 5000 is a road sweeper with a capacity of 5 m<sup>3</sup> in volume and 5,000 Kg in weight; it is steering on both axes. Dirt and refuse is picked up by a mechanical system with a dust-filtered aspirator circuit. This system picks up refuse by its nozzles, which are kept under depression by the filtered aspirator circuit. The machine works even quite bulky items with fine dust with different environmental conditions. The machine can operate by dry or wet system in order to support the sweeping action. The whole system is assisted by a set of service brushes, with two lateral brushes and one front brush.

### 2) On the basis of referring document it is inspected the sampling tests by following method:

At 2007-07-06, the tests were conducted in the Municipality of Fidenza to evaluate the performance of the Dulevo 5000 street sweeper in normal operating conditions. A simulated road cleaning scenario in an urban area was prepared for the purposes of the test. The purpose of the exercise is to determine the filtration efficiency of the filter systems installed on the street sweeper, the quantity of PM<sub>10</sub> and PM<sub>2.5</sub> particulate exhausted by the system and the dimensional characteristics (size particle fraction) of the particulate exhausted by the system. The experimental tests were conducted in the following conditions:

- The tests were carried out with dry system and without the service brushes.
- The distance travelled during each test was  $8.9 \pm 0.5$  km<sup>(1)</sup> (equal for all tests);
- The test duration was  $75 \pm 5$  <sup>(2)</sup> minutes (equal for all tests);



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# DET NORSKE VERITAS

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Report no. **IND070463**

- The engine speed of the internal combustion engines of the machines was established and maintained at an average value of approximately 2200<sup>(3)</sup> rpm, for an average road speed of 7.3<sup>(3)</sup> Km/h;
- Atmospheric conditions are provided by ARPA Emilia Romagna, department of the provincia of Parma.
- The equipment for sampling was according to UNI 10196:2001
- The collection of sampling was carried out by personnel and equipments of **LABORATORI INTEGRATI STUDIO ALFA S.r.l.** This laboratory is accredited by SINAL, No. 0231. Further details are reported on test report no. 14818/2007 issued by laboratory **LABORATORI INTEGRATI STUDIO ALFA S.r.l.** that is part and parcel of this document.

<sup>(1)</sup> The deviation for the total kilometres travelled was determined from the average of the vehicle odometer readings for each test.

<sup>(2)</sup> The deviation for the test duration was determined from the average times measured for each test.

<sup>(3)</sup> Deviations are due to traffic conditions and compliance with road signage and traffic signals.



# DET NORSKE VERITAS

Report no. IND070463

### 3) Test route

The test route was defined in the city of Fidenza (PR), including urban and extra-urban operating conditions. The test route consisted as follows:

ROUTE	DISTANCE	ZONE	DESCRIPTION OF ZONE
P1	approx. 1000 m	Viale Martiri della Libertà	City centre – tree lined avenue – medium traffic – normal asphalted road
P2	approx. 700 m	Via E. Toti	City centre – residential area – tree lined avenue – light traffic – normal asphalted road
		Via D. Chiesa	
		Via G. Borghesi	
		Via N. Sauro	
		Via E. Toti	
		Via F. Filzi	
P3	approx. 1000 m	Via Giosuè Carducci	City centre – road works area – medium traffic – impaired asphalted road
		Stazione	
		Via Mazzini	
P4	approx. 300 m	Via Abete Zoni	City centre – medium traffic – road surface in concrete paving slabs.
P5	approx. 1000 m	Via Gramizzi	Suburbs – heavy traffic – normal asphalted road
		Via 4 Novembre	
P6	approx. 3,900 m	Via XXIV Maggio	Residential area – low traffic – normal asphalted road – tree lined avenue
P8	approx. 1000 m	Via XXIV Maggio	Suburbs – heavy traffic – normal asphalted road – road works area
P9		Via F.lli Cairoli	City centre – residential area – tree lined avenue – light traffic – impaired asphalted road
P10		Viale Martiri della Libertà	City centre – tree lined avenue – medium traffic – normal asphalted road



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# DET NORSKE VERITAS

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#### 4) Test equipments, documents and records:

- US - EPA - Test method 201A – Determination of PM<sub>10</sub> emission.
- UNI 10169-2001 (European standard, Italian version): Emissions determination – Determining the velocity and flow rate of ducted gaseous flow using the Pitot tube.
- UNI EN 13284-1: 2003 (European standard, Italian version) – Determining the concentration by mass of dust in low concentrations – Manual gravimetric method.
- PTFE microporous membrane filters with a filter diameter of 47 mm and an average pore diameter of 0.5 microns;
- Corrosion resistant metal filter support with polished surfaces;
- Cyclone type PM10 and PM2.5 sampler, compliant with US - EPA - Test method 201A standards;
- Constant flow rate portable sampler – Flow meter and volumetric counter;
- Gibertini E50S analytic balance with sensitivity of 0.001 mg and measurement uncertainty of 3%.
- Laboratory heater with in-built temperature regulation; M150-VN-MPM INSTRUMENTS, Serial no. 9906370.
- PHILIPS XL30W/TMP scanning electron microscope (SEM) FEI - XL30 with EDAX DX-4 micro-analysis. Serial number: 943206635151 and R04261D6700.
- Accreditation certificate SINAL No. 0231 of **LABORATORI INTEGRATI STUDIO ALFA S.r.l.**
- Test report n.14818/2007 issued 2007-07-18 by **LABORATORI INTEGRATI STUDIO ALFA S.r.l.**

#### 5) Collection of test results

The examination of sampling PM<sub>10</sub> e PM<sub>2,5</sub> has been conduct by **LABORATORI INTEGRATI STUDIO ALFA S.r.l.** by itself personnel and equipments, according to standard EPA - Test method 201A – Determination of PM<sub>10</sub> emission. Sample of relevant results are reported into the annexes to this report. All the results are given in the test report no.14818/2007 dated 2007-07-18 issued by **LABORATORI INTEGRATI STUDIO ALFA S.r.l.** that is part and parcel of this document.



# DET NORSKE VERITAS

Annex no. I of Report No. IND070463

## MEASUREMENT OF FINE DUST EMISSION IN ATMOSPHERE FOR STREET SWEEPER MACHINES DELEVO 5000.

### Annex I

Street Sweeper 5000		
Goretex filtering Device		
Serial No 5000W00023/07		
Year of construction 2007		
Power 104KW		
Test date: July 2007		
<i>Environmental parameters</i>		
Ambient temperature* (mean)	°C	28.2
Atmospheric humidity* (mean)	%	31.2
Atmospheric pressure* (mean)	mbar	1012
Ambient PM <sub>10</sub> * (mean sampler reading over 24 hours)	µg/Nm <sup>3</sup>	15
<i>Operating parameters</i>		
Filtered air flow rate	Nm <sup>3</sup> /h	3020
Engine speed	RPM	2200
<i>Granulometric analysis (Dust captured by filtering device)</i>		
<b>Granulometric fraction &lt; 1 µm</b>	%	<b>58</b>
<b>Granulometric fraction &lt; 2.5 µm</b>	%	<b>92</b>
<b>Granulometric fraction &lt; 5 µm</b>	%	<b>98</b>
<b>Granulometric fraction &lt;10 µm</b>	%	<b>&gt;99</b>

\*figures provided by ARPA Emilia Romagna, department of the province of Parma.

The results reported on this annex are a sample. All the results are given in the test report no.14818/2007 del 07-07-18 issued by **LABORATORI INTEGRATI STUDIO ALFA S.r.l.** that is part and parcel of this document.