



# OCCUPATIONAL NOISE VIBRATION & AIR POLLUTANTS FLUCTUATION INSIDE THE TOLL BOOTHS IN THE ATHENS RING MOTORWAY NETWORK: "ATTIKI ODOS"

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### Abstract

Attikes Diadromes S.A (a company ensuring the "Maintenance – Operation and Exploitation of the motorway Elefsina – Stavros – Spata Airport & West Peripheral Ymittos Avenue "), in close cooperation with the University of Thessaly -Faculty of Civil Engineering (Transportation sector) has executed during 2006 [1] an extended specialised research program, in, both, selected toll booths of "Attiki Odos" network (Athens Ring Road) & also selected machinery equipment, aiming at the detection of both occupational & vibration noise levels possible as long as harmful chemical factors generated from the road circulation in the relevant selected toll booths of Attiki Odos, aiming at the evaluation of the relevant impact at the employees of both toll facilities & machinery equipment use are exposed during working periods.

### **1. INTRODUCTION**

This research program includes a complete series of measurements of the following environment parameters:

- Environmental & Occupational Noise according to the Greek Presidential Decree 85/18-3-91/FEK38 (as per the relevant 2003/10/EC directive of 6 February 2003) [2]
- Hand-arm & Whole body vibration according to the Greek Presidential Decree 176/2006 (as per the relevant 2002/44/EC directive of 25 June 2002) [3]
- Additionally in the respected both areas the following **Atmospheric Pollutants** were also monitored : Carbon monoxide CO / Nitrogen monoxide NO & Nitrogen Dioxide NO2 / Total volatile organic combinations TVOC /Dust (AS10)

### 2. THE "ATTIKI ODOS" ATHENS RING MOTORWAY NETWORK

The "**Attiki Odos**" motorway i.e. the "Elefsina – Stavros – Spata Airport & West Peripheral Ymittos Avenue" called also the "Athens Ring Motorway network" is presented in photo 1 hereafter and presents the following main technical characteristics:

- Total length = 65,20 Km.
- Service roads network = 31,3 Km.
- Secondary road network = 150 Km.
- Interchanges = 32 & Bridges = 104
- Tunnels = 38 & Rail bridges = 37
- Pedestrian passerelles =15
- Tunnels & C&C = 63
- Length Tunnels–C&C = 15,64 Km.
- Services surfaces =  $122.000 \text{ m}^2$
- Road traffic noise & Atm. Pollution existing monitoring network = 8 fix stations & 200 points (based on a 24hours mobile monitoring grid according to 2002/49/EC relevant directive for the environmental noise)
- Anti noise barriers already executed = 67,000 m2 (future instalments:  $5.000 \text{ m}^2$  approx.)

## **3. MEASUREMENT' S MONITORING SETUP**

The project has been executed as follows:

 Both <u>Environmental - Occupational Noise & Atmospheric Pollutants</u> were monitored for 2 (two) complete weeks (from Monday 26 June 2006 up to Monday 10 June 2006) at three selected toll areas: Metamorphosis, Kifissias and Penteli toll areas (see relevant photo 2, hereafter); the Metamorphosis tolls that are comparatively characterized by a considerable vast traffic flow – both private and heavy vehicles passages on a daily basis. The relative measurement's program was carried out in each location for a whole typical week during typical summer conditions.





The important parameters that effects the formation of all environmental / occupational noise and air pollutants are, obviously, the traffic load, the synthesis of the vehicle's flow using Attiki Odos and, also the typical remaining (background) air pollution in the immediate region. Moreover, the wind meteorological conditions had an important role, since they influence the diffusion of air pollutants. From the respective analysis of detected recordings it became clear that both, concentrations of all air pollutants and occupational noise levels, inside the working areas (booths) were found to be lower compared to the relevant permissible limits for the workers' safety and health.

The following environmental parameters were monitored in all locations using the respective instrumentation:

• For <u>the environmental & occupational noise</u> both the Leq(100ms) index & the daily noise exposure level (LEX,8h) in dB(A) ref.20 µPa: time-weighted average of the noise exposure levels for a nominal eight-hour working day as defined by international standard ISO 1999: 1990, point 3.6, according to the formula :

 $L_{EP,d} = L_{Aeq,Te} + 10 \log_{10} \text{ Te/To}$ 

$$L_{Aeq,Te} = \log 10 \left[ \frac{1}{T_e} \int_0^{Te} \left( \frac{P_A(t)}{P_0} \right)^2 dt \right]$$

using the integrated sonometer *SOLO Master* (by 01 dB France) – see adjacent photo 3, according both to relevant standards 651 και 804 (I.E.C. PUBLICATIONS 651-1979 and 804-1985) and IEC 1260 και IEC 61672-1



For the <u>atmospheric pollutants</u>: Carbon monoxide – CO / Nitrogen monoxide – NO & Nitrogen Dioxide – NO2 / Total volatile organic combinations – TVOC /Dust (AS10) both measured inside & outside the booths, the following instrumentation was also used (see adjacent photo 4) :



CO Analyser 48C (Thermo Environmental Instruments - USA) NOx Analyser 42C (Thermo Environmental Instruments - USA) T-VOC Analyser ppbRAE ( RAE Systems - USA) Dust Analyser 224-PCEX (SKC – USA) Personal Data-logging Real-time Aerosol Monitor PDR-1200 (Thermo ELECTRON –USA) TSP analyser PARTISOL 2000 (Thermo ELECTRON –USA)

2. For the **Hand-arm & Whole body vibration** according to the EU directive 44/EC selected machinery & construction vehicles were used as JCB BobCat etc.. (see photo 5 herefater) :



The relevant instrumentation used was *«Maestro»* (of 01 dB France) with 4 available chanels for both noise & vibration monitoring. In the following photos 6 & 7 both "hand arm" & "whole body" measurements setup are presented:



According to both Greek & EU legislation : (a) "hand-arm vibration": is the mechanical vibration that, when transmitted to the human hand-arm system, entails risks to the health and safety of workers, in particular vascular, bone or joint, neurological or muscular disorders; and (b) "whole-body vibration": is the mechanical vibration that, when transmitted to the whole body, entails risks to the health and safety of workers, in particular lower-back morbidity and trauma.

The relevant **exposure limit values and action values** are also as follows : (a) for handarm vibration: the daily exposure limit value standardised to an eight-hour reference period shall be 5 m/s2; and the daily exposure action value standardised to an eighthour reference period shall be 2,5 m/s2. and (b) for whole-body vibration: the daily exposure limit value standardised to an eight-hour reference period shall be 1,15 m/s2 or, at the choice of the Member State concerned, a vibration dose value of 21 m/s1,75; (b) the daily exposure action value standardised to an eighthour reference period shall be 0,5 m/s2 or, at the choice of the Member State concerned, a vibration dose value of 9,1 m/s1,75.

#### 6. CONCLUSIONS - RESULTS

Based on the above the following results, were achieved from the measurement campaign :

- Occupational noise  $L_{EP,d}$  index fluctuation in all booths /shifts is presented in the following figures 1 & 2
- Simultaneous measurements for the **most representative atmospheric pollutants** (in particular for NO<sub>2</sub> & TVOC) both for inside & outside the booths cabins are also presented in figures 3 & 4 for information purposes only.
- Representative measurements results for both **"hand-arm & whole-body"** vibration in a representative machinery type JCB are also presented in the figures 5 & 6 hereafter:



Figures 1 & 2 . Occupational noise  $L_{EP,d}$  index fluctuation



Figures 3 & 4. NO<sub>2</sub> & TVOC atmospheric pollutants fluctuation for both inside & outside the booths cabins conditions



Figures 5 & 6. Representative measurements results for both "**hand-arm & whole-body**" vibration in a representative machinery type JCB

Based on the relevant results we conclude the following:

- Regarding the **Occupational Noise** in all respected both areas the relevant results for all measurements suggests that the exposure to noise index LEP,d is less than the given criterion of 85 dB(A). The average LEP,d value fluctuates respectively for Metamorphosis, Kifissias and Penteli toll areas between 67,7 dB(A) and 77,6 dB(A), 66,2 dB(A) and 76,2 dB(A) & 59,8 dB(A) and 74,5 dB(A).
- Additionally in the respected both areas all atmospheric pollutants measurements (i.e: Carbon monoxide – CO / Nitrogen monoxide – NO & Nitrogen Dioxide – NO2 / Total volatile organic combinations – TVOC /Dust - AS10) were found also within the respected criteria in all cases.
- Regarding **Hand-arm & Whole body vibration** measurements it was found that the relevant values were within the given criteria with special emphasis in the JCB measurement's setup were drivers behaviour and wheel use found to influence all relevant measurements.

#### REFERENCES

- [1] Prof. C. Vogiatzis & Prof. N.Eliou, *Research Program "Attiki Odos Occupationnal Noise Vibration & Atmospheric pollutants Monitoring Program*", (University of Thessaly, Faculty of Civil Engineers, September 2006)
- [2] EC directive 2003/10 of 6 February 2003 on the minimum health and safety requirements regarding the exposure of workers to the risks) in respected both areas arising from physical agents (noise) (Seventeenth individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC)
- [3] EC directive 44/EC of 25 June 2002 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (vibration) within the meaning of Article 16(1) of Directive 89/391/EEC)