

## REDUCTION OF THE INDUSTRIAL EMISSIONS OF AIR POLLUTANTS IN THE FLEMISH REGION (BELGIUM) BY LAW ENFORCEMENT.

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### SUMMARY

The Flemish Region is the most northern of the three regions of Belgium. With its 5.9 million inhabitants, on a surface of 13512 km<sup>2</sup>, the Flemish Region is one of the most populated regions of Europe. Public awareness for the potential risks of air pollution in general and from industrial point sources in particular has spectacularly increased during the last decade. This phenomenon was even strengthened by events involving feed and food contamination by polychlorinated dioxins and furans in 1999.

The Environment Inspection Section is responsible for the enforcement of the environmental health legislation in the Flemish Region. The Environment Inspection Section chooses to enforce in both a preventive and a corrective way, aiming at coordinated action in the whole of the Region. In the past years, the Environment Inspection Section organized several emission measurement campaigns, which were performed by certified external laboratories. These campaigns were complementary to the obligatory "self-control" measurements and aimed at investigating the emissions of air pollutants by industrial point sources.

The results of the emission measurements were compared with the legal standards or emission limit values and if needed, the Environment Inspection Section imposed measures in order to obtain cleaner emissions. These measures could be brought under administrative and/or criminal law and led to a thorough reduction of the emission of pollutants of all kind and, in particular, of polychlorinated dioxins and furans.

Between 1993 and 2000 the major efforts were aimed at the municipal solid waste incinerators and since 1997 a similar approach has been applied to industrial process plants, leading to additional reductions of polychlorinated dioxins and furans emissions. The following reviews the Flemish experience with regulation of municipal solid waste incinerators.

### 1 INTRODUCTION

One of the main tasks of the Flemish government is to maintain and improve the quality of the environment. Therefore, in recent years a legal framework has been established to protect and improve the environment. In the EU (European Union), there is a great tendency to make environmental policy and laws

at the European (and national or regional) level, while they have to be executed at the regional and local level. In order to implement these rules and regulations, which are mostly based on legislation, adequate instruments are being used, such as:

1. permits, licenses, exemptions and general rules
2. taxes

3. environmental impact assessment
4. safety reports
5. certifications
6. voluntary agreements
7. education and information of the public  
However, if no action is taken to enforce those rules and regulations, they will remain "paper tigers" which will not be effective in protecting the environment.

## 2 THE CONCEPT OF THE "REGULATORY CHAIN"

Informed approaches to environmental protection recognize that in order to reach a certain goal through environmental regulation, five steps have to be taken. Those steps are known as the "regulatory chain" or the "regulation cycle." The first step is to ensure that rules and regulations are based on an agreed upon environmental policy. The second step is to formulate standards that have to be met. The third step is to apply these standards in particular cases through licensing. These first three steps require only changes on paper. The fourth step is implementation: it requires either a change in behavior or investment in technology. The fifth step is enforcement: the set of actions necessary to make the regulated community comply with the rules.

Step four dictates that, to get results, certain measures must be taken both by companies and by the government. For example, companies may be obliged to install air filters or afterburners. However, if one of the conditions of a license is that waste must be disposed of in an environmentally friendly way, the government will have to facilitate this option. With respect to enforcement, step five requires that rules be enforced to ensure that the required measures will actually be effective. Because people and companies tend to take the easiest and cheapest way out, having greater concern for themselves and their financial interest than they have for the environment, the last step in the chain is a critical link.

## 3 PRINCIPLES OF ENFORCEMENT

### 3.1 Introduction

As people do not automatically comply with all the rules and regulations all the time without a certain amount of coaxing, whether it is persuasion, reward or punishment, you need enforcement to achieve compliance. Enforcement is defined here as the set of legal actions governments or others take to achieve compliance and to correct or halt situations that endanger the environment and public health.

### 3.2 Preventive And Repressive

Legal enforcement generally is divided into two types: preventive and repressive enforcement. Preventive enforcement is the regular inspection of companies. Repressive enforcement takes place when an individual or a company seriously violates the requirements and those violations are discovered. Regular inspections (preventive enforcement) are important for several reasons. Inspections remind companies to continue to comply. They can identify serious violations that could induce repressive enforcement. "Serious" violations are emphasized here, because minor violations are often corrected immediately, sometimes by means of negotiation education.

Another reason why inspections are vital is that during an inspection visit, an official can see if the requirements are technically and economically feasible and assess whether they are enforceable. For example, an inspector can note whether prescribed equipment is working, as it should. If equipment such as a monitoring device is not operating correctly, it may be impossible to measure the concentration of a certain pollutant.

Repressive enforcement or sanctioning is a necessary element of enforcement. It is the legal stick used to either threaten or, if necessary, beat the donkey. This type of enforcement often begins when the official encounters a serious violation during a regular inspection. An incident or a complaint can also lead to repressive enforcement.

### 3.3 Elements Of Enforcement

Enforcement thus usually includes inspections, negotiations, and legal action. Inspections need to be conducted as necessary to determine the compliance situation in the community and to detect people or companies that violate the rules. Negotiations may be useful if people or companies do not comply with the rules and alternative compliance schedules and other approaches, including compliance funding or technical assistance, appear most likely to successfully change the targeted behavior. Finally, the stick of legal action can be necessary if there is a risk of real danger to public health or the natural environment or if companies have resisted previous opportunities to comply. A real or perceived threat, including a threat of individual liability, can sometimes persuade an otherwise recalcitrant facility operator to take measures to comply.

### 3.4 Importance Of Enforcement

Enforcement is important and necessary to achieve the goals of protecting public health and improving environmental quality. In addition, enforcement ensures fairness, protecting companies that comply with environmental regulations from being economically disadvantaged by companies that do not comply. This protection also safeguards the economic interests of the community, which would otherwise bear the costs of the advantage obtained through noncompliance.

Enforcement is also necessary for maintaining credibility. When the regulated community does not take environmental regulations seriously, the credibility of the government is at stake, not only in environmental affairs but also in other areas. Finally, enforcement makes sense economically by, among other things, improving public health and reducing the cost of medical care, saving money both in the short term and long term by cleaning water and soil, and by stimulating development, use, and marketing of innovative pollution control technologies.

### 3.5 Deterrence

As a general rule, 20% of the population will comply voluntarily with a (new) rule; 5% will never comply unless forced to do so, and 75% will comply only if they see that others receive a sanction for non-compliance. In other words, most people will change their behavior to avoid a sanction. For deterrence to work, four conditions have to be met: there must be a good chance that violations will be detected; the response to violations must be swift and predictable; the sanctions must be appropriate; and the first three conditions must be communicated to and recognized by the community.

### 3.6 Feedback

National and regional regulations and targets must be translated into "enforceable" requirements. Enforceable means that the regulations provide the regional/local level with the necessary authority and that they are clear and practical. Although it is no use to set requirements that are unclear, imprecise or technically not feasible, it sometimes happens; especially in cases where national or regional governments feel the need "to do something." To help enhance the likelihood of compliance, the regional and local authorities could design a system to evaluate requirements and guidelines issued by national or regional governments and use results from the evaluations to give information to the people who draft the rules.

## 4 THE FLEMISH SITUATION

As far as the Flemish regional administration is concerned, the instrument for the enforcement of environmental health legislation in the Flemish Region is the Environment Inspection Section of The Ministry of the Flemish Community. The Environment Inspection Section has operated since 1991, and is not involved in the process of granting licenses. About 85 inspectors are active in the Environment Inspection Section, which consists of an Inspectorate-general, in charge of the general management, a Chief Inspectorate

having a coordinating and supporting task and an Inspectorate service in each of the 5 Flemish provinces, performing the actual inspections in the field.

If their findings indicate sufficient necessity, the inspectors of the Environment Inspection Section can decide to take measures in the field of criminal or administrative law. They always make an official report of the legal violations to the Public Prosecutor and they can give statements. If needed, they can initiate coercive measures, leading even to the closing-down of a plant. For air pollution control, the findings of the inspectors are generally based on the results of emission measurements, which have to be performed by certified and officially recognized labs.

## **5 CLEANUP OF MUNICIPAL SOLID WASTE INCINERATORS IN THE FLEMISH REGION.**

### **5.1 Introduction**

One example of legal enforcement efforts initiated by the Environment Inspection Section, the cleanup of air pollutant emissions from municipal solid waste incinerators, has resulted not only in the observance of the legal standards, but also served as an impetus to technological innovation (Figure 1 — see website).

The Flemish Region is one of the three regions of Belgium, making up the northern part of the country, with 5.9 million inhabitants on a surface of 13.512 km<sup>3</sup>. In this region, one of the most heavily populated areas in Europe, about 3.3 million tons of household waste are produced annually. Currently, about 800,000 tons of household waste is incinerated in 12 existing municipal solid waste incinerators, with a total yearly capacity of about 1.2 million tons. Associations of municipalities (so-called 'intercommunales') mainly operate these municipal solid waste incinerators and most of them are located in the western part of the Flemish Region (Figure 2).

The major decree of the Flemish Legislation on Environmental hygiene is the Environmental License Decree of 1985,

which became operational through two implementing orders, called VLAREM I (1991) and VLAREM II (1995). VLAREM I contains a list of the objectionable establishments needing a license (class 1 and 2), or that need to be reported on a municipality level (class 3), and the procedures required to obtain a license. VLAREM II contains the general and sector-related conditions for objectionable establishments of all three classes. These conditions are based on the general principle of prevention and refer to BAT (NEEC). For various sectors, such as waste incineration, emission limit values are given. Where possible, these emission limit values of course are based mainly on the European directives.

### **5.2 Vlarem II On (Municipal) Waste Incineration**

For municipal solid waste incinerators, VLAREM II mentions emission limit values that depend upon the capacity and the type of waste, which is incinerated. For municipal waste incinerators, the emission limit values are different for capacities below 1 ton/h, between 1 and 30 ton/h and above 30 ton/h. All existing Flemish municipal solid waste incinerators have a capacity between 1 and 30 ton/h. These emission limit values are taken from the EU directives for new and existing municipal solid waste incinerators (1989), but additionally, an emission limit value of 0.1 ng TEQ/Nkm<sup>3</sup> for polychlorinated dioxins and furans has been obligatory for all Flemish municipal solid waste incinerators since 1/1/1997.

VLAREM II mentions very explicitly that the incinerators are not allowed to continue operation when the emission limit values are not being met (Table 1). An extensive monitoring scheme is obligatory, including continuous measurements of several parameters. Since 1/1/2000, continuous flue gas sampling, with biweekly analysis of the dioxin emission, is also obligatory. In this way, a constant review of data on the operation of the municipal solid waste incinerators has become possible. Furthermore, the Environment Inspection Section can perform emission measure-



ELV (mg/Nkm <sup>3</sup> )	< 1 ton/h	1-30 ton/h	> 30 ton/h
dust	100	30	10
CO	100	100	100
TOC	20	20	10
HCl	100	50	10
HF	4	2	1
SO <sub>2</sub>	300	300	50
NO <sub>x</sub>	400	400	400
Cd+Tl	0.2	0.1	0.05
Hg	0.2	0.1	0.05
heavy metals	5	1.5	0.5
PCDD+PCDF (ng TEQ/Nkm <sup>3</sup> )	0.1		

**Table 1: Vlare II: emission limit values for municipal solid waste incinerators**

<b>continuous</b>	O <sub>2</sub> , T°, p, H <sub>2</sub> O dust, CO, HCl (>= 1 ton/h)
<b>6-monthly</b>	TOC heavy metals, HF, SO <sub>2</sub> , NO <sub>x</sub> (>= 1 ton/h) dust, HCl, CO (< 1 ton/h)
<b>annual</b>	PCDD+PCDF
<b>continuous</b> sampling for <b>bi-weekly</b> PCDD/PCDF analysis	

**Table 2: Vlare II: emission measurements for municipal solid waste incinerators**

Inspection Section ordered the immediate and thorough sanitation of the municipal solid waste incinerators in order to reach the legal emission limit values and to minimize the dioxin emissions. To obtain this goal, at least a substantial improvement of the process controls (temperature, air flows, waste input) and an installation or extension of the existing flue gas cleaning system would be needed.

Following this first campaign, 6

municipal solid waste incinerators were closed-down definitively as the cleanup measures required appeared not to be feasible, for economical and/or technical reasons or because the authorities granted no new license. The 13 other municipal solid waste incinerators started pollution control upgrade programs involving implementation of one or more improvements. Those measures included improvement of the process controls, revisions of the oven,

upgrading of electrostatic precipitators (ESPs), installation or extension of the flue gas cleaning system (e.g. fabric filter, wet scrubber or semi-dry reactor with  $\text{Ca}(\text{OH})_2$  injection), and in a limited number of cases, injection of activated carbon or lignite.

### 5.5 Phase 2: 1997-2000

In 1998, the Environment Inspection Section organized a new emission measurement campaign at the municipal solid waste incinerators. In the meantime, the VLAREM II emission limit value for PCDD/PCDFs, had become operational.

All of the municipal solid waste incinerators had a primary and secondary flue gas cleaning system, and at nearly all, activated carbon was injected in the flue gases.

The measurement results showed that the emission limit value for the 'classical' parameters (dust, HCl,  $\text{SO}_2$ ,  $\text{NO}_x$  and heavy metals) was met at all municipal solid waste incinerators. The flue gas PCDD/PCDF concentration was lower than  $0.1 \text{ ng TEQ/Nkm}^3$  at nearly all municipal solid waste incinerators, but still appeared to be the most critical factor. Meanwhile, the public awareness for PCDD PCDFs had risen and the Flemish Parliament approved a motion in which it was stated that plant operation could not be tolerated if the emission concentration was higher than the emission limit values.

Therefore, the Environment Inspection Section chose to maintain a strict enforcement policy, especially for the PCDD/PCDF emission limit value. At all plants where a concentration above  $0.1 \text{ ng TEQ/Nkm}^3$  was measured, the Environment Inspection Section investigated whether this was caused by structural problems. If so, the municipal solid waste incinerator was ordered to immediately stop the incinerator and to take the necessary measures. Afterwards, the Environment Inspection Section decided whether the start-up could be allowed. This was only permitted if the operator could prove that the emission limit value would be respected at all times.

The result of this action was that one more municipal solid waste incinerator had to be closed-down definitively, as the necessary investments could not be economically made. Several other municipal solid waste incinerators were stopped temporarily by the Environment Inspection Section until all measures were taken to assure a flue gas concentration of less than  $0.1 \text{ ng TEQ/Nkm}^3$ . Specifically regarding the PCDD/PCDF emission reduction, typical measures taken during this period were injection of activated carbon or lignite, optimized fabric filter operation, catalytic filter sleeves, deNO<sub>x</sub> (Selective Catalytic Reduction) as a final step for dioxin removal, and continuous sampling for biweekly dioxin analysis (obligatory since 1/1/2000).

Furthermore, all of the municipal solid waste incinerators managed to obtain a much higher quality level of operation, and thus lower emissions, because of further improvements in process control ( $T^\circ$ , air flow), a better management and improved training of their personnel. Several of them have currently obtained an ISO 14000 certificate.

### 5.6 Technological Progress And Innovation

Between 1993 and 2000, huge environmental investments were done at all Flemish municipal solid waste incinerators. This ranged from between approximately 3 million to over 30 million U.S.\$ per incinerator. (Table 3)

Major adaptations were improved process controls ( $T^\circ$ , residence time, air flow), high-quality burners, energy recovery systems, upgrading of ESP and wet scrubbers, installation of new fabric filters, use of activated carbon injection equipment, activation of improved or new lime reactors (semi-dry system), use of deNO<sub>x</sub> systems (catalytic and non-catalytic), and continuous monitoring equipment to provide biweekly analysis of dioxins.

These investments resulted in a huge decrease of the average yearly emissions. This is most striking for the total dioxin emission from municipal solid waste

	TOTAL number of incinerators	ESP or Cyclones	Ca(OH) <sub>2</sub> injection	activated carbon injection	catalytic filter sleeves	wet scrapper	deNO <sub>x</sub> (SCR/SNCR)	deNO <sub>x</sub> (SCR/SNCR)	continuous monitoring including dioxins
1993	19	17	2	1	0	0	3	0	0
2002	12	12	12	11	11	2	7	3	12
CLOSED since 1993	8								
New incinerators	1								

**Table 3: Flue gas treatment at municipal solid waste incinerators in the Flemish Region: situation 1993 vs. 2002**

incinerators, which has decreased from over 120g TEQ/year in 1993 to less than 1g TEQ/year at the moment. This shows that the investments really have proven their value in terms of environmental benefit (Figure 3).

## 6 CONCLUSION

Between 1993 and 2000, a substantial improvement of the flue gas emission quality of the Flemish municipal solid waste incinerators has been obtained due largely to technological innovations at the plants. The stimulating force to reach this result was the strict enforcement of the VLAREM II environmental legislation by the Environment Inspection Section. The Environment Inspection Section managed to organize its own measurement campaigns and, based on the results of these measurements and on the results of the obligatory self-monitoring program, the Environment Inspection Section took actions under both criminal and administrative law to accomplish a thorough cleanup of the Flemish municipal solid waste incinerators.

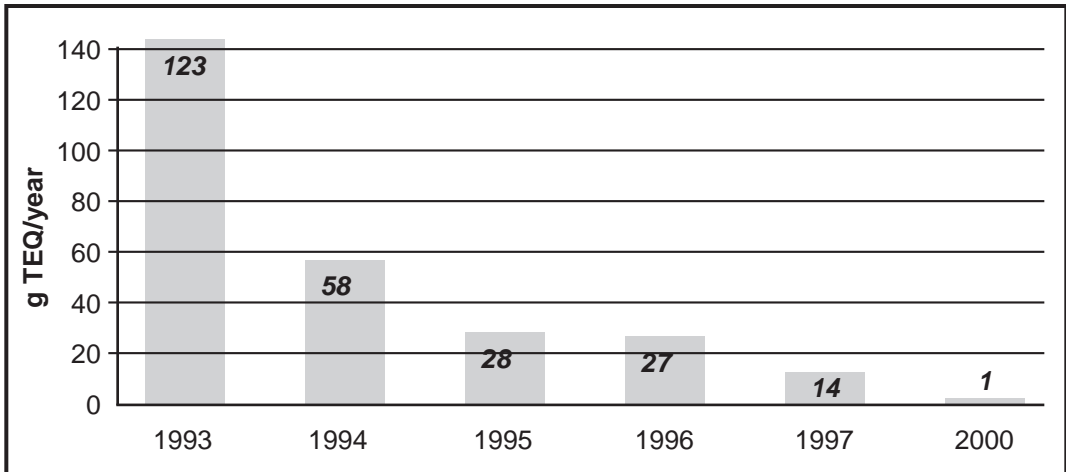
The Environment Inspection Section ensured that the legal emission limit values, especially the one for PCDD/PCDF,

are respected at all times. If the limits are ignored or exceeded, the operation of the municipal solid waste incinerators will be temporarily stopped until needed measures are implemented. Only if the operators can prove that the emission limit value will be permanently respected under normal operating conditions will the Environment Inspection Section allow further operation.

This approach induced a striking improvement in both the attitude of and the technology applied by the operators, shifting the Flemish municipal solid waste incinerators from a 'retarded' to a 'high-tech' industrial sector and achieving a marked reduction of toxic substance emissions.

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**Figure 3: Average yearly PCDD/PCDF emission from municipal solid waste incinerators in the Flemish region**

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