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SEVESO INSPECTIONS IN THE EUROPEAN LOW COUNTRIES

Implementation and effectiveness of the European Seveso Directives in Belgium and the Netherlands

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ABSTRACT

The so-called Seveso legislation regulates the prevention of major accidents in which hazardous substances are involved in Europe. It is trans-national legislation that has to be translated into national law in every European Member State. This article investigates the role of Belgium and the Netherlands in this Seveso legislation and a thorough discussion of how it is implemented in these so-called European Low Countries is provided. Furthermore, the inspection approach for these specific regulations in both Member States is described and analysed.

Keywords: *inspection, Seveso legislation, chemical industry, Low Countries*

1. INTRODUCTION

1.1. The European Seveso legislation

Regulation is one of the defining features of modern society. More than a century ago, the French sociologist Emile Durkheim stated that modern industrial society is highly differentiated, and laws should coordinate this diversity to protect public interests (Durkheim, 1893). These laws do not necessarily correspond to a deeply held sentiment in society, they are expedient to achieve public policy goals to protect workers, local residents and so forth.

Safety regulation is about regulation of risk, and differs from many other kinds of regulation. Society gains an advantage from industrial activities. It is very difficult to separate these

activities from the risks being connected with them. Industrial safety regulations require to minimise the risks of those who control the workplaces (Hopkins and Hale, 2002).

It took some time before the concept of risk was introduced in the safety domain. One of the first to mention likelihood, or probability, was the American Lewis DeBlois (1926). He worked as chairman of the safety commission of the DuPont de Nemours department 'high explosives', a company with a natural affinity to safety ever since some explosions took place early 19th century in the company. DeBlois introduced a new doctrine, against the universal belief that accidents 'just happen'. Accidents are caused and the relevant causes can be prevented, was his statement. The likelihood of an accident is both a combination of exposure to a hazard and of the likelihood of a technical failure, creating a danger. He did not mention the word risk, but he used some important aspects that would form a central part of the risk-based approach in the period after World War II.

Frequently, questions were raised whether regulation of safety was necessary at all. During the interbellum period, safety engineers postulated the relation between safety and efficient production (see for an overview Swuste et.al., 2010). Later, economists argued that safety was simply good business, and that accident prevention could be left to the market. Damage claims by those who suffer injury or loss would create a strong economic incentive to reduce risks to a minimum. There are many objections against this 'simplistic' view; for instance, although a safe production indeed is good business and there is no argument against that, due to the tension between productivity and safety, and due to managers' limited time in a function and therefore limited responsibility for their decisions, market forces tend to increase risks, and damage claims fail to control risks in a more proactive way.

In Belgium, the city of Antwerp strongly developed as a classical trading harbor in the 19th century, and the petrochemical industry only emerged in the 1930s with the construction of two refineries. Chemical industrial activities in Antwerp on a large scale really took off after WWII when two additional refineries and the first ethylene oxide production facility started in 1951. Between 1951 and 1963, the first series of downstream refinery products emerged. In 1963, two steam crackers and corresponding ethylene processing capacities made the port of Antwerp an important petrochemical complex in Europe. Further growth was achieved in phases, making the Antwerp chemical cluster the second largest cluster worldwide after Houston, Texas (USA) nowadays. When including the industrial areas of Rotterdam-Rijnmond, Bergen op Zoom, and Flushing as one cluster, the chemical cluster becomes the biggest in the world if looking at the density of chemical industrial activities per surface area. Furthermore, this cluster is in very close proximity to major residential areas.

In the Netherlands, the discussion on industrial risks was influenced by developments in flood defence and control. With one third of the country surface below sea level, flood defence was a major issue. In the 1930's a different approach to flood control was introduced, using risk assessment methods for tidal flood levels. It was customary to increase the height of levees to slightly above the level of the last flood. Statistical analysis dictated that an absolutely safe dike did not exist but that there was a probabilistic relationship between the height of levees or sea dikes and flood risk. Despite earlier warnings to the government before World War II, the probabilistic approach was adopted only after the 1953 Great Flood in the South-West of Holland and Zeeland, causing 1,836 fatalities. Soon after, the Delta Works project was started and policy decisions for flood safety and dike heights were based solely on risk assessments. The maximum permissible exceedance was determined at 10^{-4} per year, defined as the probability that the water height is equal to, or higher than the dike height (Oostendorp et.al., 2016). These developments in flood safety had a major impact on the risk-based and probabilistic approach in the industrial safety domain.

In the post war period, chemical and petrochemical plants in The Netherlands and other major industrial countries went through a fast development phase. Technology was new and business was booming. There was an upscaling to higher production volumes, a growth much larger than periods before. These plants were operating at higher temperatures and pressures. Nobody knew exactly what was going on. Also in the process industry, a rather arrogant and closed behaviour was dominant at that time. 'Trust us, we know what we are doing', was the attitude. As a result, after some (now well-known) major accidents in the 1960s-1970s, including the 1976 Seveso one, European society perceived the process industry to be a very dangerous sector. This has led to the European Seveso I directive in 1982. Next to political consequences of these major accidents, this 1960s-1970s period was also the start of a more systematic, comprehensive, and technical approach to industrial safety, known as 'Loss Prevention' (Kletz, 1999).

Apart from the upscaling of the process industry, like in Rijnmond – which is the Rotterdam harbour area – other events played a decisive role in Dutch discussions on industrial risks. In the Rotterdam Rijnmond area, but also in the rest of the country, frequent industrial explosions and fires were killing and injuring workers, and creating a public aversion against the process industry (see for instance Het Vrije Volk, 1968, 1972; De Waarheid, 1971; Dort, 2014). 1973 was the year of the energy crisis, and in 1978 the Los Alfaques disaster occurred in Spain with an LPG tank-car, killing more than 200 people, mostly Dutch tourists.

The energy crisis showed the fragile dependency on oil as a main source of energy. LNG and LPG were seen as alternatives, and plans were developed to import liquefied natural gas from Algeria and to build storage facilities in the Rotterdam - Rijnmond area. The public debate on LNG super tankers into Rotterdam harbour led in 1975 to spectacular visions of vapour cloud explosions with the power of an atomic bomb. These exorbitant projections drove the need to get a better grip on the problem and to create some numbers for the political decision making process. The debate on the acceptability of risks had started and a more realistic concept of risk was slowly accepted within the former Dutch Ministry of Public Housing, Spatial Planning, and Environment. The dominant 'zero-risk' view, till then dominant, was being replaced by a probabilistic approach. The LNG discussion took place against the background of a growing number of new industrial activities in the Netherlands that would involve huge amounts of hazardous materials. The discussion about adverse consequences for local residents provided the motive for risk research in the seventies. The limited land space in the Netherlands forced consideration of safe separation distances between the (process) industry and residential areas. As risk-based research progressed, the definition of risk as a combination of the probability and the effects of incidents became increasingly accepted. According to Pasman (1999), this definition had a structuring effect on the public debate on risks, and reduced the debate to more realistic proportions.

In 1978 the so-called LPG integral study, influenced by the LPG-related Los Alfaques disaster that happened in the same year, was investigating dangers of LPG during road transport, at tank filling stations and at storage and transshipment facilities (TNO, 1983). Different methods developed in the process safety domain were used in conjunction with methods for calculating physical effects. The report mentioned the complexity of the concept of risk, and suggested three different measures to assess consequences and likelihood of the occurrence:

- The average number of expected deaths;
- The probability that an individual person is killed at a particular location or area;
- The probability that a certain number of people are killed at the same time in the total area affected.

Much later the last two measures became the basis for defining the criteria for the individual risk (now called "location-based risk") at a given location (PR, 10^{-6}) and the Group Risk (GR, FN plot). The most serious scenario considered in the TNO study of 1983 was a Boiling Liquid Expanding Vapour Explosion (BLEVE). With flammable liquids, e.g. propane, an initial explosion is sometimes followed by an intensely burning fireball. The researchers limited their analysis to a technical risk analysis concerning public safety. They extensively

discussed uncertainties of the risk analysis related to the design and construction of engineering systems, assumptions about failure and consequence probabilities, and the influence of human factors. But hard numbers infused the social debate.

Another study, the so-called COVO study quantified public health risks of industrial installations in the Rotterdam - Rijnmond area (Cremer and Warner, 1982). COVO stands for a Dutch abbreviation of safety committee of residents in the Rijnmond area. The previous conducted British study at the industrial area of Canvey Island served as an example (HSE, 1978). It was the first quantitative risk assessment that identified industrial risks to which the residents were exposed to in the vicinity of chemical industry parks (Pasman and Reniers, 2013). From the discussions during the COVO study it became clear that quantification of probabilities and consequences did not automatically lead to risk acceptance. Complex social, psychological and societal factors were playing an important role in debates on risk and risk acceptance, both in and outside the Netherlands. Probability calculations were often, it was thought, based on guesswork and the uncertainty surrounding probabilities was seriously underestimated (Wetenschap en Samenleving, 1978; Reijnders, 1979). Furthermore, a comparison of the risk figures, in which non-equivalent activities were compared, made little sense. Not all risks were voluntarily taken and risk acceptance was ultimately a political issue presented as a scientific problem (Boskma, 1977; Leij and Mutgeert, 1977; Boesten 1978, 1979).

1.2. Research questions

From a legislative point of view the European Seveso directives played and still play a central role in controlling safety in the European process industry sector. This study will describe and analyse the implementation and effectiveness of Seveso directives in Belgium and in the Netherlands. Effectiveness will be translated into the quality of inspection practices of chemical companies, related to the Seveso Directive. The study is limited to the so-called Low Countries, being Belgium and the Netherlands, and the following research questions are leading:

1. How is the European Seveso legislation on chemical industries politically implemented in Belgium and in the Netherlands?
2. How is the control of this legislation organised in these countries?
3. How effective is the control of this legislation in these countries?

2. MATERIALS AND METHODS

To answer the research questions, documents from governmental and public sources discussing the implementation and quality of the Seveso directives in Belgium and the Netherlands were retrieved from internet. However, a search in scientific literature, using search terms as SEVESO and INSPECTION, SEVESO and DIRECTIVE did not result in many relevant papers.

In Belgium, publicly available information was used wherever possible. For example, safety reports are publicly available, and the European Seveso legislation has been translated into Belgian law in a so-called 'Samenwerkingsakkoord' (or cooperation agreement) between the different regions of the country. Furthermore, available scientific studies (e.g. Spriet, 2013) were used.

In the Netherlands quality issues related to Seveso inspections were obtained from reports of the Dutch Labour Inspectorate, governmental commissions, the Brzo website, and of the Dutch Safety Board. This board started in 2005 as an independent organisation conducting safety research on major accidents in industry and pipelines, health care, construction, aviation, rail and road transport, and defence. Like reports of the Dutch Labour Inspectorate, and governmental commissions, also reports of the Dutch Safety Board (OVV) are public, and the ones on industrial disasters were selected and examined on remarks regarding Seveso II inspections.

Finally an overview of major accidents in Belgium and the Netherlands was obtained from the open literature, from scientific articles dealing with this topic, and from branch organisations (Lees, 1996; Mannan, 2005; Zwaailichten, 2015; Wikipedia; Dort, 2014; CSB 2010; Khan et.al., 1999; Mihailidou et.al., 2012; Thomson, 2013)

3. RESULTS: SEVESO I, II, III IMPLEMENTATION

3.1. Organisation of Seveso inspections

Seveso I

The Seveso I directive, issued in 1982, was an attempt to obtain a minimum standard of harmonisation amongst European Member States on major hazard regulation. The handling of dangerous substances was a central point of the regulations, and a list of these

substances was included. The principal requirements of Seveso I can be summarized as explained by Kirchsteiger et al. (1998):

- Each European Member State should appoint a so-called “Competent Authority” (CA)
- The operator shall prove at any time to the CA that major hazards connected with the installation have been identified and adequate safety measures have been taken to prevent accidents
- When inventories of dangerous substances exceed specified thresholds, the operator shall provide the CA with a written safety notification (or ‘safety report’), shall prepare an on-site emergency plan, and shall give the information needed by the CA for the preparation of off-site emergency plans
- Major modifications to the installation shall be notified to the CA
- The CA shall provide for external emergency planning
- Member States shall ensure that people liable to be affected by an accident be ‘actively’ informed of the safety measures and how to behave in case of an accident
- The operator shall report to the CA any major accident which occurs, the CAs should then notify these events to the European Commission
- The Commission shall keep a register of accidents so that Member States can benefit from this experience for the purposes of prevention of future accidents.

In a safety report, companies thus needed to describe their production processes, safety systems to control these processes and to avoid emissions, exposures, and disaster generating situations. The directive was changed several times after major industrial accidents of the 1980s. Mexico-City (1984), Bhopal (1984), Piper Alpha (1988), and the environmental disaster at Sandoz-Basel (1986). Several sectors were dealt with. First were the LPG stations and storage sites, followed by Seveso-companies. After the 1986 Sandoz accident in Switzerland, releasing tons of agrochemicals in the air and the river Rhine and killing almost all river wildlife, also storage sites for pesticides and chemicals were dealt with by the Seveso legislation from then on. Moreover, ammonia refrigerating units, (rail) transport of hazardous chemicals and safety of airports were also under the attention of the regulators. Models developed in studies mentioned above were documented in standardized textbooks for risk analysis in the Netherlands, the so-called ‘coloured books’. Four books were published, the yellow one (CPR E 14, 1979) on risk analysis of hazardous substances, the red one (CPR 12^E, 1988) on failure risks of technical installations, the green one (CPR 16, 1989) on damage models, and finally the purple one (CPR 18, 1999) on quantitative risk analysis. These coloured books contributed to the development of the Seveso Directives (Oostendorp et.al., 2016).

These industrial accidents induced amendments in 1987 and 1988, making the Seveso I legislation very dynamic, but also creating a considerable administrative burden for both the companies and the supervisory authorities. The directive was dealing with effects on humans, and hardly with any dangers for the environment (Bottelberghs, 2000; Oh, 2002; Vierendeels et.al., 2011). In 1989 the need for a major revision of the Directive was laid down in a resolution of the Council of Ministries identifying the lack of provisions for a land-use planning policy with respect to major accident hazards in order to decrease the vulnerability of the environment into which an accident may develop its consequences.

Seveso I and Belgium

The translation of the European Seveso I Directive into Belgian law was a very difficult and complex process. The cause of the difficulties are the many state reforms in that era, leading to problems regarding the division of powers and responsibilities between regional authorities and federal authorities. The Seveso Directive encompassed different domains such as occupational health and safety, civil protection, and environmental protection. While the first two domains belong to the responsibility of the Belgian federal government, environmental protection resorts under the power of the regional governments (Flanders, Wallonia, and Brussels). The implementation of Seveso I was thus scattered among different regulatory departments at different levels in Belgium.

Seveso I and the Netherlands

In 1981 a safety report became a legal commitment in the Netherlands. In 1988, the Major Accidents (Risks) Decree (Brzo-Besluit risico zware ongevallen) was implemented (Arbeidsinspectie 1989). Three Ministries were responsible: the Ministry of Social Affairs and Employment, The Ministry of the Environment, and the Ministry of the Interior. According to the decree, Seveso establishments had to deliver information on two topics; one report on occupational safety, and one on environmental safety based upon a QRA.

Seveso II

When the Seveso I directive was a prescriptive ‘tell us’ directive, Seveso II became a performance-based ‘prove to us’ directive. This changed the burden of the regulator in assessing the safety conditions of a company. Seveso II was an extension of the Seveso I directive. Both Seveso Directives were driven by major industrial accidents. The focus was on establishments rather than on installations, removing the ‘loophole’ where a split of activities and storage facilities into smaller units could allow an ‘escape’ from the obligations

imposed by the Seveso I legislation. There was also attention for domino-effects, and the earlier list of chemicals was improved and extended in a more systematic list.

Two thresholds were installed: a low one and a high one. If companies stored or processed amounts of dangerous chemicals higher than the low threshold, they were called 'Seveso companies'. If the amounts of chemicals was below the high threshold, companies belonged to a so-called 'light category' of chemical companies (so-called Seveso tier I companies). Exceeding the high threshold put companies in a 'severe category' (so-called Seveso tier II companies), subjecting them to more strict regulations such as having to submit a safety report to the Member State authorities. A prevention policy was the main issue of the new regulation. This included the introduction of inspections and the necessity to organise a safety management system, and finally land-use planning around Seveso establishments. Land-use planning in the Low Countries was a hot item, due to a high population density in close proximity to industrial installations. Amendments on this directive in 2003 were a response to the environmental disaster of the gold mine at Baia Mare, Romania (2000), the firework explosion at Enschede (2000), and the ammonium nitrate explosion at Toulouse (2001) (Vierendeels et al., 2011).

Seveso II and Belgium

Within the complex Belgian federal structure of the state, the translation of the Seveso II Directive into Belgian law was not at all an easy task. Due to the fragmented approach in case of the Seveso I Directive, whereby an integrated policy for the prevention and the mitigation of major accidents was completely lacking, the federal government and the three regional governments opted for a far-reaching type of collaboration, that is, a normative Cooperation Agreement having the power of law. This Cooperation Agreement between federal and regional governments in Belgium which came into force on 26 June 2001, concerns the cooperation and tasks of the authorities involved, as well as the obligations of the industrial operators.

The powers of the inspectors are divided between the (regional) environmental inspection (environmental Permit Authority), responsible for the protection of the surroundings of the establishments, for both people and environment, and the (federal) so-called chemical risk inspection (which can be seen as a Labour Inspectorate), responsible for the protection of the employees of an establishment. Inspectors of both these services form one inspection team, respecting each other's responsibilities, but adding each other's knowledge. In case of certain Seveso establishments subjected to specific Belgian legislation on explosives, underground storage of gas, and/or transportation of fluids and other products via pipelines,

inspectors from the federal ministry of Economic Affairs, are responsible. The three inspection teams need to set up an inspection system in collaboration with each other. The coordination of all inspections is the task of the federal chemical risk inspectorate.

An inspection represents a plan-wise and systematic investigation of the technical-, organisational- and company systems to verify whether (i) adequate measures have been taken to prevent major incidents, (ii) major accident consequences, on-site and off-site, can be adequately mitigated, and (iii) data and information, comprised in the establishment's documents (e.g. a safety report), are a truthful representation of the real situation.

The Cooperation Agreement allows inspectors to provide recommendations and formal warnings before issuing a police report. In practice, the establishment is notified in writing of any shortcomings or unclarified issues. Following this notification, the establishment drafts the necessary actions and defines a timeframe for their implementation. If needed, and the establishment does not live up to its expectations/requirements, it is possible to send it to court. In contrary to the Netherlands, no public accessible reports were available on the effectiveness of Belgian Seveso II inspections.

Seveso II and the Netherlands

The Seveso II directive from 1996 came into force in the Netherlands in 1999 with Brzo 1999. From that year onwards so-called Brzo-companies were defined. The total number of these companies varied per year, around 400-430. In 2015, 387 Brzo-companies were active (Ministerie van Infrastructuur en Milieu, 2016; Brzo+, 2016). A list of these companies, including their names, addresses, and responsible inspection sectors were made public from 2014 onwards (Brzo+, 2016a).

The introduction of the directive was not an easy task. National political discussions aimed to reduce the administrative burden and to reduce governmental involvement in safety issues. Seveso II was pointing in the opposite direction. Policy makers of ministries involved, implemented this directive in a unique way. Brzo 1999 was one integrated decree, based on four different laws, and signed by three Ministries mentioned above. Three law enforcement authorities were executing the decree, being the Labour Inspectorate, the Environmental Permit Authority and the Fire Brigade. The Labour Inspectorate delegated their tasks to a subdivisions, the Major Hazard Control group, formed in 2002. Each authority kept its own enforcement responsibility. The permit authority, a local authority on a community of provincial level, is linked to the environmental law. Permits are issued before an activity is granted, or a factory is built. The Labour Inspectorate is bound by the Labour Condition Law,

where a safety management system is a central issue. The Inspectorate has a long tradition of technical inspections at industrial companies. The Fire Brigade has a completely different organisation. Local community fire brigades, often organised voluntarily, work with regional, or company fire brigades. There is no tradition in inspection, and demands to a company are made by the environmental permit (Oh, 2002).

When a company is lacking implementing safety measures, the inspector can issue a formal warning, or demand. The company is given a certain period of time to adjust, and to install the (required) measures asked for by the inspection. At the end inspectors, can send companies to court. They also have the option to instantly shut down a site, and again a judge has to check whether or not the action is lawful. The inspectorate is not involved in any environmental permit procedure. Their focus is health and safety of workers, which generally are exposed to hazards orders of magnitude bigger than residents living in the vicinity of a factory. They can require costly adjustments to sites, and factories with a permit which are already in operation.

Seveso III

The third version of this European legislation, the so-called Seveso III Directive, entirely replaced the second Seveso Directive as of 1 June 2015. The third revision goes hand in hand with the enforcement of the CLP legislation, concerning the Classification, Labelling and Packaging of chemical substances and mixtures. A new division of chemicals and the introduction of new categories of substances, such as inflammable aerosols, led to the observation that some companies became Seveso establishments as from 1 June 2015, where they used to be none. The most important modification of Seveso III is indeed the harmonization with the CLP legislation, but Europe has also seized the moment to also further improve and expand the second Seveso Directive.

Seveso III introduces a completely new information obligation, as information now needs to be provided to the public in a permanent way, amongst others online, hence in an electronic way. Furthermore, a new article regarding the feedback in case of a major accident was introduced: the authorities need to inform the public about the causes and consequences of the accident, and about the measures that have been decided upon as a result. The public will also be consulted in case of the settlement of new Seveso establishments, certain major modifications to existing establishments, or certain developments near such establishments.

Seveso III further has some new stipulations regarding the inspection of Seveso establishments. Inspections need to be driven by an inspection plan, at a national, regional

or local level. Such a plan needs to geographically indicate its application area, and needs to contain a list of installations and establishments. It further needs to contain a list of groups of establishments where domino effects can occur. It also needs to contain a general evaluation approach of the relevant safety issues and procedures for routine inspections (planned) and non-routine inspections (non-planned, but as a result of incidents or complaints for instance). Inspection is strengthened by imposing that there needs to be a follow-up inspection (obligatory) within 6 months if serious shortcomings have been determined in an establishment. Furthermore, the minimum inspection frequency for lower tier Seveso establishments has been fixed by Seveso III on 3 years. For upper-tier Seveso-establishments following the previous Seveso II legislation, the minimal inspection frequency was already set to be yearly. Moreover, inspection services themselves now need to write an inspection report within 4 months of the inspection. All Member States need to make sure that it is possible to stop an establishment's activities when inspection requirements are not met.

Seveso III and Belgium

The third Seveso Directive has no major implications for Belgium, as many requirements were already met in the application of the second Directive. The Cooperation Agreement regulating Seveso II in Belgium already asked for an active information obligation and an open government obligation. This will most probably be further expanded following Seveso III. The inspection programs were also already very elaborate and no important changes are expected due to Seveso III in Belgium. As with Seveso II inspections, the vast majority of inspections is announced beforehand to the company involved (Spriet, 2013).

Seveso III and the Netherlands

As is the case in Belgium, also in the Netherlands the third Seveso Directive has no major implications, apart from the revised classification boundaries for 'toxic' and 'flammable' chemicals, and a lower threshold for 'flammable aerosols'. Like Belgium most of the inspections are announced beforehand to companies involved. In the Netherlands this concerns 90% of all inspections (Brzo+, 2016b)

3.2. Approach and quality of Seveso inspections

Approach and quality of Seveso inspections in Belgium

In Belgium, every region as well as the federal government have their inspection responsibilities. They all have inspectorates operating and cooperating with each other based on equality and aimed at specific tasks and competences. The federal inspectorate coordinates the inspection visits to the establishments. The frequency of inspection visits of Seveso-companies in Belgium is based on the so-called 'danger potential' of every establishment, without making a distinction between lower tier and upper tier companies. The procedure to determine the basic frequency for the inspection of any Seveso establishment is based on a hazard index methodology. After the calculation of the fire and explosion index (F) and the toxicity index (T), every installation within a Seveso establishment is classified into a certain danger category, going from I (low 'danger potential') to III (high 'danger potential'). The danger category of the entire establishment (composed of a number of installations) then equals the highest danger category of one of its installations. Furthermore, a distinction is made between so-called 'simple establishments' and 'other establishments' when determining the basic inspection frequency, as shown in Table 1.

Danger category	Minimal inspection frequency for 'simple installations'	Minimal inspection frequency for 'other installations'
I	3-yearly	3-yearly
II	3-yearly	2-yearly
III	2-yearly	yearly

Table 1. Determining the basic inspection frequency in Belgium

As can be seen in Table 1, the frequency of establishments may thus vary between once a year to once per three years. Simple establishments are establishments in which merely storage and loading- and unloading activities of hazardous materials take place, and no reaction processes.

The objectives and focus of every inspection visit is well-planned and determined beforehand. By inspection of a part of the company during every visit, eventually over the years an overall inspection picture is obtained of every establishment. The 'inspection program' per establishment provides an overview per so-called 'inspection domain', past, present and planned. The following inspection domains are defined per establishment: process installation, operational personnel, dangerous work, emergency planning, incidents and accidents, prevention policy major accidents. These domains allow to assess the safety

situation in a very structured, systematic and plan-wise way, using so-called 'Seveso Inspection Tools' or SITs. SITs are questionnaires developed via the cooperation of the federal and regional inspection services. The SITs are published online (publicly available) and can be consulted by any organisation, for example wishing to prepare for a planned inspection. Seveso III may give input to further change of the inspection domains.

The inspectorates each internally developed an instrument in which procedures and responsibilities for an inspection are well-described. The federal inspectorate disposes of an ISO 9001 certified quality system for inspections. All labour inspectors need to master this system via internal training and a system of coaching. The regional inspectorates have developed a document describing different tools for doing the inspections. Furthermore, all inspectors in Belgium need to be MSc in engineering. Usually, the inspection is carried out in one day. In case of very small companies, half a day will satisfy.

Inspection services are financed via a system where Seveso top tier companies need to pay a so-called Seveso-contribution (some kind of tax) feeding the so-called Seveso Fund. The Seveso Fund not only serves to finance the federal inspectorate, also other expenses for the prevention of major accidents are funded with it.

Some numbers related with Seveso and the inspections are the following. There are 386 Seveso-companies in Belgium, of which 210 high-tier companies and 176 low-tier companies. 280 of these Seveso-companies are situated in Flanders, 102 in Wallonia, and 4 in Brussels (FOD WASO, 2016). Furthermore, there are 18 federal inspectors of the (coordinating) chemical risk inspectorate (federal Ministry of Labour and Social Affairs), 13 regional inspectors from the Flanders' environmental Permit Authority, 10 inspectors from the Wallonian environmental Permit Authority, and 1 from the Brussels region environmental Permit Authority.

Approach and quality of Seveso inspections in the Netherlands

Practice is often more unmanageable than legislation let us believe. This was reflected in different sources, discussing the efficacy of the Brzo-degree. The first evaluation of the Brzo '99 in the Netherlands concluded the decree had a positive effect on occupational safety, external safety and the preparation on disaster relief (Cap Gemini, 2004). For both lower tier and upper tier companies a safety management system was obligatory. Safety management was an item already discussed in occupational safety during the interbellum period and just after World War II with Heinrich's safety ladder (Heinrich, 1950). In process safety in the 1970s the Robens' report (1972) from the UK stimulated the discussion on safety

management (for an overview see Swuste et.al., 2016), and focussed the responsibility of (process) safety to companies.

Deficiencies in safety management systems were frequently reported between 2003-2010 in publications of the Major Hazard Control (MHC) group of the Dutch Labour Inspectorate (Major Hazard Control group, 2005, 2006, 2007, 2011). In these reports industrial accidents and incidents were analysed, using a Tripod analysis and the bowtie metaphor. Maintenance, and maintenance management in these companies were less than adequate, together with an insufficient risk assessment, design deviations, and an absence of supervision of dangerous tasks. Inspectors also noticed a poor focus on process disturbances, especially during start-ups and shut downs of production lines. In quite a few companies safety awareness of management was minimal or absent.

Inspection services are financed by ministries responsible for Brzo, in 2016 being the Ministry of Infrastructure and Environment, the Ministry of Social Affairs and Employment, and the Ministry of Justice and Safety.

Discussions on the responsibility for occupational and process safety, and quality of Brzo supervision were held in various governmental reports, advisory commissions, several independent reports of accident analyses of the Dutch Safety Board, and a PhD thesis (Cap Gemini, 2004; Grave, 2005; Mans, 2008; WRR, 2012; OVV 2012-2014; RLI, 2013; Kluin, 2014) (table 2).

date	redactor	subject
Feb 2004	Cap Gemini Ernst & Young	Work in progress, interdepartmental evaluation of Brzo '99
Jun 2005	Commission de Grave	Governmental task analysis 'You're either in charge, or you're not'
Aug 2008	Commission Mans	Revision enforcement system 'The time is ripe'
Feb 2012	OVV-Dutch Safety Board	Report Chemie-Pack, Moerdijk (huge fire)
Nov 2012	Scientific Counsel for Governmental Policy	Inspection on companies in the chemical industry
Jun 2013	OVV-Dutch Safety Board	Report safety Odfjell Botlek (emission C ₄ H ₁₀ , C ₆ H ₆)
Jun 2013	Council for the Environment and Infrastructure	Safety Brzo-companies, responsibilities and decisiveness
Jun 2014	OVV-Dutch Safety Board	Report explosion Shell Moerdijk June 3 rd 2014 (fire, explosion)
Nov 2014	PhD thesis Delft University of Technology	Optical compliance

Table 2 Reports and advises to improve Brzo performance

The present and former chairman of the Dutch Safety Board were active in this debate (Vollenhoven, 2008; NOS, 2016), as well as the Dutch Society of Safety Science (Dik et.al., 2008), and the director of the Major Hazard group (Veld, 2009, 2015, 2016). All stressed the importance of safety management systems and pointing to a compartmentalised and

fragmented governmental approach to process safety. Discussion continued within meetings of the Contact Group Health and Chemistry (Jongen and Swuste, 2012, 2014; Swuste and Jongen 2009). Summarising, four themes frequently returned in these publications, being fragmentation of the regulatory system, lack of expertise of organisations responsible for supervision, the dependency of inspections, and disappointing effectiveness of enforcement activities.

The first type of fragmentation was related to the location of Brzo-companies. Provincial and local authorities were, and are responsible for issuing environmental permits to Brzo-companies, and for the supervision on compliance. The number of organisations dealing with these companies is large. These authorities often lack the expertise and the scale require to fulfil their duties. Till a few years ago, they did not have the capacity to act in case of offences. The Mans' Commission (2008) pointed to an extreme high level of administrative pressure for companies and organisations. More than 500 different governing bodies were dealing with environmental law enforcement, and these bodies often lacked the expertise to judge or issue environmental permit applications of companies, Reginal Implementation Services (RUD – Regionale UitvoeringsDienst) were set up. These RUD's combined local authorities, provinces, and regional water authorities, and focussed on the improvement of quality and safety of the living environment. RUD's became active in 2013. In total 25 RUD's were covering the country, 6 of them were specifically designed for Brzo regions, being Brabant, Rijnmond (DCMR), Groningen, Limburg, Nijmegen and Noordzee kanalengebied. Another type of fragmentation is the distinction between 'internal safety', and 'external safety'. Internal safety is the health and safety regulation of the Labour Conditions Law, a basic law with only general rules, and no permit system. There are no norms for acceptable levels of risk, and the legislation is based upon the (theoretical) principle of 'zero-risk'. The Environmental Management Act provides norms for acceptable risks, and a quantitative risk assessment approach is central to the law. Generally, norms for environmental exposure are a factor 100 lower than norms for occupational exposure, meaning civilians are much better protected than workers, who are on top of industrial hazards (Veld, 2009, 2016). This legislative complexity created inspection teams where every inspector follows the remit of the Ministry they represented. Also The Dutch Safety Board mentions the coordination between different inspectors, which could be improved. If there is a difference in opinion in the inspection team, there is no authority to make decisions. The Safety Board concludes in one of its reports that the lack of a clear institutional framework reduced the effectiveness of Seveso enforcement activities (OVV, 2013).

Supervising high-risk activities demands high-level experts, being the inspectors. Nationally this expertise is available. Apart from expertise, there is a problem with the numbers.

Professional specialists, capable of performing inspection are limited. The MHC group of the Dutch Labour Inspectorate has 40 inspectors. This number of inspectors remained constant over the period of the Brzo inspections. Austerity measures related to budget cuts only will increase the capacity shortage, which mainly reduced the number of inspectors of the Fire Brigade and the Environmental Permit Authority. The total number of inspectors varied between 150 and 200. These inspectors are controlling 244 high-tier and 143 low-tier companies, being in total 387 companies (Brzo+, 2016b). The dependency of both companies and ministries is addressed a few times, also recently (NOS, 2016, Veld, 2016). Both in Belgium, and in the Netherlands inspection visits are announced, and when a company objects, the inspection is postponed. Different from Belgium, the Dutch inspection costs are paid by ministries involved, meaning inspection teams may be subjected to political influences. Both the former chairman of the Dutch Safety Board and the Major Hazard Control group are pleading for an independent inspection organisation.

Various coordination initiatives have been introduced to limit the effects of fragmentation, to reduce the inspection pressure for companies, and to provide relevant education for inspectors, including the public disclosure of relevant documents. BeterZo (inspection method, supervision model, education), LAndelijk regieTeam (country wide operation team) LAT Brzo (education – Brzo Academy), LAT RB (methods and techniques) are examples of these initiatives (LAT Brzo, 2011). The success of this approach was reported to parliament in a letter from the State Secretary of the Minister of Infrastructure and Environment (Dijksema, 2016). Compared to 2014 with 15 category 1 violations, 2015 showed a reduction of five of these violations. Category 1 implies a direct danger for a major accident. Also the total number of violations of Brzo-companies dropped with more than 25%, from 850 to 615.

4. DISCUSSION

This article indicates that the European Seveso legislation is implemented in Belgium and the Netherlands in a similar way, although some differences exist between both countries. The way in which inspection services are arranged differs with respect to parties involved and to financing. It is difficult to indicate which inspection method is most optimal, since some country-specific characteristics need to be taken into account when making the qualitative comparison.

Remarkable differences exist between the countries, as shown in this paper. First of all, there is the public availability of documents and reports on the scope, the nature, and the efficiency of Seveso II/Brzo-companies and their inspections. While in the Netherlands summaries of inspection reports of individual companies, including the companies' names, are made

public, Belgium seems to keep this type of information non-disclosed. Even when general reports on individual major accidents are made available for the public, no company name is mentioned. The Belgian federal Ministry of Labour and Social Affairs provides a list of 32 industrial accidents. Reports on these accidents were compiled with the company concerned, resulting in only a description with no company name, or date, location, industry sector, and no information whether or not a Seveso company was involved.

A second difference is the number of reported accidents of Seveso-companies (table 3). There are only two notifications of major Belgium industrial accidents, compared to 47 from the Netherlands. These remarkable differences might be a result of country specific characteristics, like differences in registration discipline, or registration control. According to authors this difference in numbers does not allow a conclusion of a major efficiency of the Belgian implementation of Seveso-degrees.

A third difference is the ratio of inspectors versus Seveso-companies. Belgium has 32 inspectors and 386 Seveso-companies, while the Netherlands has almost a similar number of companies (387) inspected by a team between 150 and 200 inspectors. The Belgian number of inspectors is lower, because only two parties are involved, the environmental, and labour/process safety inspection. In the Netherlands the fire brigade and the authority for water control is part of the inspection team. But still the difference in number of inspectors is remarkable.

Furthermore, another difference is that in Belgium all inspectors need to be a MSc in engineering, while in the Netherlands no such condition exists.

As mentioned in the introduction, safety regulations are complex, due to the profit for society of industrial activities. Complexity is also an item on high-hazard-high-tech industries, including process industries. These industries emerged 30-40 years ago, and apparently we are still unable to master the hazards and risks generated (Le Coze, 2013). Another question is the acceptability of these industrial risks. No one has found a convincing answer yet for all parties involved.

All that is left are the numbers. In table 3 the period before Brzo inspections (1980-1998) is depicted, together with the period of these inspections (1999-2014). The second period shows a rise in numbers, which is expected, due to a different registration. More attention generates higher numbers, a phenomenon also observable in accident reporting. Table 3 does not allow a conclusion of a failure of Seveso legislation, because of the numbers. The table does not allow an opposite conclusion either. It does show an almost constant

incidence of major incidents and accidents, supporting Le Cozes' argument. Research on the effectiveness of Seveso legislation for a Safety Science point of view should focus on disaster scenarios in a limited number of sectors of the process industry with comparable production processes, and managerial supports. Research should focus on disaster scenarios, which directly or indirectly have been stopped due to the impact of Brzo inspection and Seveso legislation.

CONCLUSIONS

The first research question refers to the implementation of the Seveso legislation. Both countries adopted a rather complicated strategy, by spreading responsibilities over two (Belgium) to three (the Netherlands) governmental parties. In Belgium the Seveso Directives are implemented via a Cooperation Agreement between the different Belgian regions. Referring to Sir Robens with his famous 1972 report, this division might reflect the power distribution amongst ministries related to major accidents, but is a major precondition for inefficiency. Regarding the Dutch experience, and the reports for different organisations, published between 2004 and 2014, one can say Robens may have had a point. In Belgium there is no major criticism until now on the inspections, although some major accidents happened within the Belgian Seveso industry. There seems to be lack of transparency to a certain degree, or at least an opportunity to improve public openness, both in terms of inspection results and companies required to improve with respect to safety.

The Dutch Seveso-degree was implemented as Brzo (Degree Risk Major Accidents), and a list of Brzo-companies, together with Brzo inspections started during the implementation of Seveso II in 1999. Between 2008 and 2014 severe criticism on these inspections focussed on the fragmentation of the regulatory system, the lack of expertise of local authorities, and the disappointing efficacy of enforcement activities. Apart from the fragmentation, other points have been dealt with effectively. The efficacy of Seveso regulation is a very difficult point. Major accidents, and emissions of hazardous chemicals still occur in the Netherlands.

In answering the second research question, deficiencies of Dutch inspections were adequately dealt with, with the exception of the shared responsibility, and financing by three Ministries. The Belgian experience is difficult to trace, due to the lack of relevant information. Belgium is, like the Netherlands, highly industrialized, and one would expect a similar number of major incidents and accidents as its neighbour. Belgium lacks a National Safety Board, which in the Netherlands conducts independent safety analyses. Nonetheless, it seems that major accidents in the Netherlands happen more often than in Belgium, but

further research is needed to confirm this observation, and if so, to investigate the causes for this.

The answer to the third research question, the effectiveness of the legislation, is a difficult one, and a question which does not receive a lot of political attention. In the Netherlands the State Secretary showed an improvement in 2015 compared to 2014 in violations. Similar comments are coming from Belgium. It is difficult to draw any conclusions from these numbers

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date	location	sector, company	cause	deaths injured	†;
1980	Mar 26	Ne – Enschede	C ₃ H ₈ , gas cloud explosion		
	Jul 24	Ne – Rotterdam	oil tanker	crude oil	no injured
1981	Jun 24	Ne – Rotterdam	ore-bulk-oil ship Agio Ionnis	Oil, explosion	6†, 3 injured
1983	Jun 13	Ne – Botlek	process industry Akzo	C ₂ H ₄ explosion	1 injured
1985	Jan 10	Ne – Den Helder	fish factory	Cl ₂ emission	31 injured
1987	Jul 3	Be – Antwerpen	distillation column	C ₂ H ₄ O, explosion	no injured
	Feb 24	Ne – Alphen ad Rijn		Cl ₂ emission	30 injured
	Jun 10	Ne – Zeewolde	swimming pool	Cl ₂ emission	94 injured
1988	Apr 7	Ne – Beek	polyethylene plant	C ₂ H ₄	no injured
	Dec 13	Ne – Botlek	process industry DSM	C ₆ H ₅ CO ₂ H, maintenance storage tank	7† 3 injured
1989	Oct 17	Ne – Botlek	storage Pakhoed	H ₂ CHN explosion	2†, 3 injured
1990	Jan 23	Ne – Botlek	shipyard Verolme	explosion	4†
1992	Jun 30	Ne – Lijnden	LPG storage	fire	no injured
	Jul 8	Ne – Uithoorn	process industry Cindu	raising temperature, explosion	3† 11 injured
1993	Sep 18	Ne – Langerak	wood fibre industry Labe	dust explosion	3† 14 injured
1994	Apr 8	Ne – Zaandam	process industry Eurofil	explosion	1† 7 injured
1995	Jul 26	Ne – Naarden	process industry Quest	explosion	1 injured
1996	Feb 28	Ne – Rotterdam	storage CMI	chemicals, fire	no injured
	Oct 8	Ne – Enschede	storage tanks	explosion	2 injured
1997	Jan 28	Ne – Botlek	process industry Kemira	TiCl ₄ cleaning, explosion	1† 3 injured
1998	Jul 3	Ne – Pernis	refinery Shell	(CH ₃) ₃ OCH ₃	1† 14 injured
1999	Oct	Ne – Geleen	process industry DSM	HCN emission	no victims
2000	May 12	Ne – Drachten	waste treatment ATF	PCB's dioxine fire	124 injured
	May 13	Ne – Enschede	fireworks storage	explosion	23† 950 injured
	Sep 13	Ne – Dongen	glue factory Trobas	explosion	2 injured
2001	Sep 19	Ne – Amsterdam	BP termina	fire	1 injured
	Oct 15	Ne – Velzen Noord	Steel works Corus	fire	2 injured
2002	Jul 4	Ne – Putten	fourageretail Hamstra	explosion	2†
	May 7i	Ne – Hengelo	metal company Hengelo	explosion	1†
	Nov 7	Ne – Vlissingen	refinery Total	fire	3 injured
	Dec 12	Ne – Europoort	refinery Kuwait	LOC desulpherasation, explosion	1† 1 injured
2003	Apr 1	Ne – Geleen	process industry DSM	start up	3† 2 injured
	Jul 15	Ne – Eindhoven	tank car	LPG fire	1†
2004	Jul 30i	Be – Gellingen	piping	gas explosion	24† 132 injured
	May 4	Ne – Vlissingen	refinery Total	explosion	3 injured
	Aug 5	Ne – Bergeijk	storage Diffutherm	bitumen tar plasma, explosion	4 injured
2005	Mar 15	Ne – Groningen	process industry Perkinelmer	NaBH ₄ , explosion	1† 1 injured
	May 31	Ne – Warfum	natural gas treatment NAM	maintenance, gas cloud explosion	3† 2 injured
	Jun 23	Ne – Rotterdam	process industry Cerexagri	explosion CS₂	2 injured
2006	Mar 8	Ne – Rotterdam	process industry Nerefco	explosion	1 injured
	Mar 30	Ne – Botlek	container AVR	LOC C₆H₄CICCl₃ HCl	no injured
2008	Nov 28	Ne – Rotterdam	process industry Vopak	explosion	2 injured
2009	Feb 13	Ne – Botlek	refinery Kuwait	fire	no injuries
	Jul 11	Ne – Nijmegen	process industry Kelco	carboxylmethylcellulose, fire	1†
2011	Jan 5	Ne – Moerdijk	process industry Chemie Pack	fire	no injured
	Jun 6	Ne – Botlek	terminal, Rubis	fire	1 injured
	Nov 7	Ne – Farmsum	process industry Dow Benelux	Na fire	no injured
2013	Nov 19	Be – Antwerpen	refinery Total	steam explosion	2†
	May 5	Ne – Botlek	process industry Akzo	C₂H₄ explosion	1 injured
2014	Jun 3	Ne – Moerdijk	process industry Shell	explosion	2 injured

Be: Belgium, Ne: the Netherlands, **bold**: Dutch, Belgium Seveso/Brzo-companies

Table 3 'Man-made' major accidents in the process industry in Belgium and the Netherlands

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