

## **Adding value to plant performance**

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### **Introduction**

For around a decade, the French LNG terminals have experienced major organisational changes, the opening of gas market in Europe, an increase of the number of customers and the number of different ships calling at the terminals. Despite these changes which have been a source of disturbance for the management and the operators, the safety results and the overall performance of the plants have been constantly improved.

The choice made at the end of the 1990s to implement an integrated management system has been the point of reference during the last ten years, adding value to plant performance whatever the internal and external reorganisations and changes.

After a short description of the company Elengy, and a summary of the requirements of Seveso II Directive, we present the chosen standard, the ISRS© from DNV, and the results for Elengy after more than 10 years of use. We then focus on two subjects: accidents management and inspection of assets.

In June 2009, the Montoir-de-Bretagne plant was the first French plant to reach a level 7 ranking under ISRS7©. During the 2011 DNV audit of both Fos-Tonkin and Fos-Cavaou LNG Terminals, the two plants have also been rated at level 7. This result is a recognition of the level of maturity of the management system of the French LNG terminals and of the operators' professionalism.

### **Presentation of Elengy**

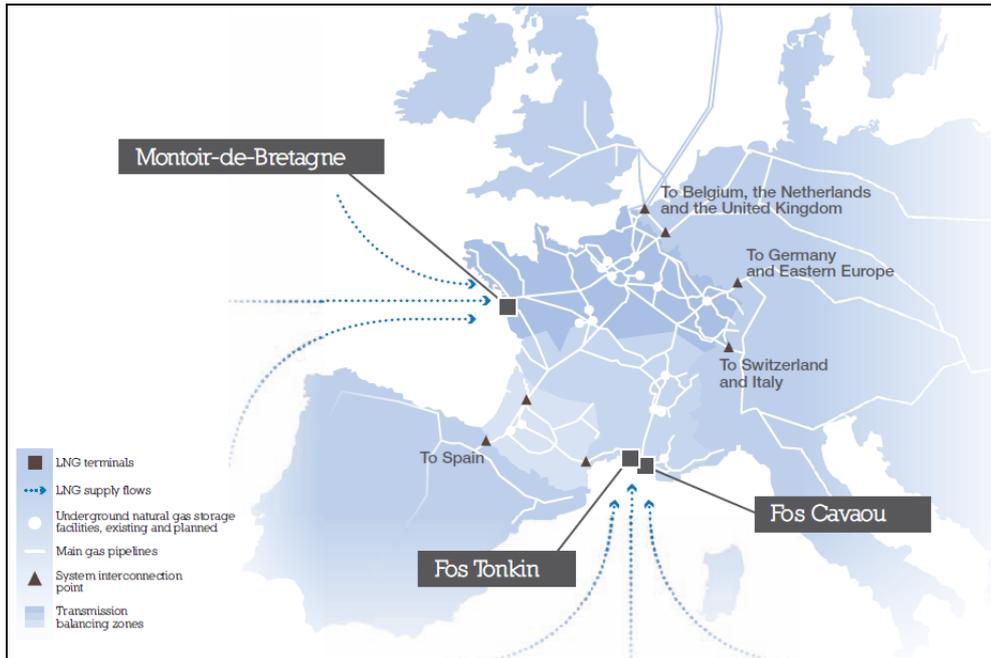
Elengy has more than 45 years of experience in designing, developing, operating and maintaining LNG terminals, i.e. facilities to receive and regasify natural gas imported in liquid form (LNG). Elengy currently owns and operates the LNG terminals of Fos Tonkin, on the shores of the Mediterranean, and Montoir-de-Bretagne on France's Atlantic coast.

It also operates the terminal of Fos Cavaou owned by the Société du Terminal Méthanier de Fos Cavaou (STMFC – the company of the Fos Cavaou LNG terminal), in which Elengy's share is over 70%.

Offering access to all LNG importers for the French and broader European markets, Elengy's terminals cater for vessels of all sizes and unload LNG from many countries around the world. It thus contributes to the security and competitiveness of LNG supplies to France and Europe in general. A subsidiary of GDF SUEZ, Elengy operates independently, under the supervision of the French Energy Regulation Commission (CRE). Its goals:

- To strengthen its position as a leading LNG terminal operator by providing safe, competitive and innovative solutions for its customers;
- To leverage its LNG expertise in order to contribute to new international projects.

Figure 1 : Location and main characteristics of LNG terminals operated by Elengy



Montoir-de-Bretagne	Fos-Tonkin	Fos Cavaou
Start in 1980 Capacity : 10 Bm <sup>3</sup> /year Tanks capacity : 360 000 m <sup>3</sup> Ships up to 270 000 m <sup>3</sup>	Start in 1972 Capacity : 5,5 Bm <sup>3</sup> /year Tanks capacity : 150 000 m <sup>3</sup> Ships up to 75 000 m <sup>3</sup>	Start in 2010 Capacity : 8,25 Bm <sup>3</sup> /year Tanks capacity : 330 000 m <sup>3</sup> Ships up to 260 000 m <sup>3</sup>
Record of the number of unloaded tankers in one year : <b>118</b>	Record of the number of unloaded tankers in one year : <b>235</b>	Owned by Elengy at 70%  Operated by Elengy through an O+M agreement

### Background for the need of a safety management system

The story begins in December 1996 with the publication of the European Council Directive 96/82/EC on the control of major-accident hazards - so-called Seveso II Directive.

The Seveso II Directive has fully replaced its predecessor, the original Seveso Directive. Important changes have been made and new concepts have been introduced into the Seveso II Directive. This includes a revision and extension of the scope, the introduction of new requirements relating to safety management systems, emergency planning and land-use planning and a reinforcement of the provisions on inspections to be carried out by European States.

The introduction of safety management systems has taken into account the development of new managerial and organisational methods in general and, in particular, of the significant changes in industrial practice relating to risk management which have occurred over the past ten years. One of the main objectives of this obligation is to prevent or reduce accidents caused by management factors which have proven to be a significant cause of accident in over 90% of the accidents in the European Union since 1982.

As defined in Annex III of the Seveso II Directive, “*the safety management system should include the part of the general management system which includes the organizational structure, responsibilities, practices, procedures, processes and resources for determining and implementing the major-accident prevention policy*”. The figure 2 provides an extract of the annex III of the Seveso II Directive which describes the requirements related to safety management system.

Figure 2: Extract from the Annex III of the Seveso II Directive

**Extract of the Annex III of the Seveso II Directive**

The following issues shall be addressed by the safety management system:

- (i) **organization and personnel** - the roles and responsibilities of personnel involved in the management of major hazards at all levels in the organization. The identification of training needs of such personnel and the provision of the training so identified. The involvement of employees and, where appropriate, subcontractors;
- (ii) **identification and evaluation of major hazards** - adoption and implementation of procedures for systematically identifying major hazards arising from normal and abnormal operation and the assessment of their likelihood and severity;
- (iii) **operational control** - adoption and implementation of procedures and instructions for safe operation, including maintenance, of plant, processes, equipment and temporary stoppages;
- (iv) **management of change** - adoption and implementation of procedures for planning modifications to, or the design of new installations, processes or storage facilities;
- (v) **planning for emergencies** - adoption and implementation of procedures to identify foreseeable emergencies by systematic analysis and to prepare, test and review emergency plans to respond to such emergencies;
- (vi) **monitoring performance** - adoption and implementation of procedures for the ongoing assessment of compliance with the objectives set by the operator's major-accident prevention policy and safety management system, and the mechanisms for investigation and taking corrective action in case of non-compliance. The procedures should cover the operator's system for reporting major accidents or near misses, particularly those involving failure of protective measures, and their investigation and follow-up on the basis of lessons learnt;
- (vii) **audit and review** - adoption and implementation of procedures for periodic systematic assessment of the major-accident prevention policy and the effectiveness and suitability of the safety management system; the documented review of performance of the policy and safety management system and its updating by senior management.

Member States had up to two years to bring into force the national laws, regulations and administrative provisions to comply with the Directive. From 3 February 1999, the obligations of the Directive have become mandatory for industry as well as the public authorities of the European States responsible for the implementation and enforcement of the Directive.

### Choice made by Elengy

The French LNG Terminals are subject to the Seveso Directive, due to the huge amount of LNG stored in the tanks of the terminals.

Elengy was thus required to establish a Safety Management System (SMS) before February 1999.

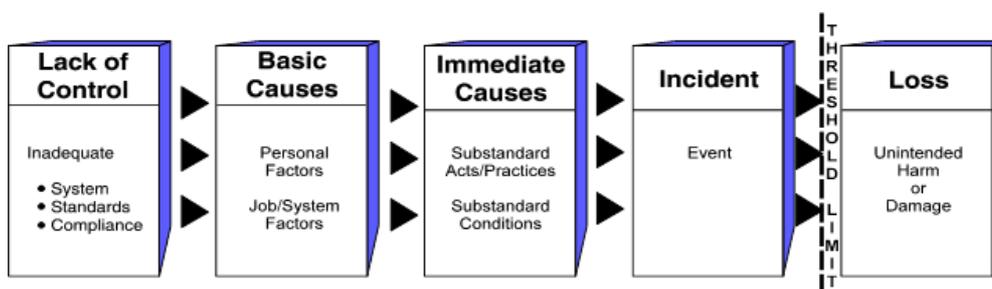
To fulfil this requirement, Elengy launched a call for tenders and finally chose the international system for safety management developed by Det Norske Veritas (DNV): the ISRS© (International Safety Rating System).

### Description of the ISRS©

In 1969, a study of industrial accidents was undertaken by Frank E. Bird, Jr., who was then the Director of Engineering Services for the Insurance Company of North America. Bird analyzed 1,753,498 accidents reported by 297 cooperating companies. These companies represented 21 different industrial groups, employing 1,750,000 employees who worked over 3 billion hours during the exposure period analyzed. He was interested in the accident ratio of 1 major injury to 29 minor injuries to 300 no-injury accidents first discussed in the 1931 book, Industrial Accident Prevention by H. W. Heinrich. His works led to define the famous "Bird's Pyramid".

ISRS© first edition was developed in 1978 by Frank Bird following his research on industrial accidents. This research demonstrated that accidents do not just happen but are caused. Accidents typically result from multiple causes which link together to result in a loss event. Frank Bird showed that the causation could be usefully broken down into Immediate and Basic Causes. Then these basic causes were the result of management system failure. The Loss Causation Model describes how accidents are caused. It is also a powerful model to prevent accidents. It indicates that if a management system is in place with adequate system elements, performance standards and compliance with those standards this will eliminate the causes of accidents.

Figure 3: Loss Control Management (source DNV)



This ISRS© system is both a collection of good practices and an assessment tool.

It enables the establishment of a recognized management system, initially focused on health and safety (version 6).

The assessment using the ISRS© involves interviews with operators where questions are answered and scored. Detailed verification is conducted on the performance of the management processes and the physical assets, and organisations must be prepared to show evidence to support their answers. The process scores determine an overall level of performance between 1 and 10. The results provide a detailed measure of performance and

a gap analysis compared to the organisation's desired level of performance. This becomes the planning basis for improvement during the next period.

ISRS© adopts a structure based on 15 processes, embedded in a continuous improvement loop in common with other standards (ISO 9001, ISO 14001).

Figure 4: ISRS© processes embedded in the ISO continual improvement loop (source DNV)



### Initial goals for the French LNG terminals

All organisations differ in terms of their purpose, risks, size, complexity, maturity, and stakeholder expectations. So, ISRS© can be adjusted to meet these differing needs by selecting the appropriate Target Level in a range from Level 1 to 10.

Before an organisation is assessed against ISRS©, its management team should decide what Target Level of performance it will aim for. This decision will be based on many factors including:

- Risks on site;
- Complexity of the business processes;
- Maturity of the management system;
- Available management time & resources;
- Industry benchmarks;
- Stakeholder expectations.

For Elengy terminals, the decision which was taken at the beginning of the process ten years ago, was to have a target award level in the range 6 to 7.

### A necessary evolution in rating systems

Since that time, the implementation of this system in LNG terminals has evolved to include environmental and quality aspects (ISO 14001 and ISO 9001).

It should also be noticed that the implementation of a quality, environment and safety management system is requirement of the European Standard EN1473 "Installation and equipment for liquefied natural gas - Design of onshore installations »:

*"The design, procurement, construction and operation phases should all be implemented in accordance with the requirements of the Quality, Health, Safety and Environment management systems as described in EN ISO 9000 and EN ISO 14000 series.*

*Furthermore each phase shall be controlled by an acceptable Safety Management System."*

In parallel to this, DNV has also modified the ISRS© system, in partnership with several industrial groups, including GDF SUEZ. ISRS© 7th version (ISRS7©), which was first tested in France at the Montoir LNG Terminal, not only provides a level of recognition on health and safety but also allows users to obtain ISO certification.

DNV developed ISRS 8<sup>th</sup> Edition incorporating Process Safety Management in 2009 to include the specific controls needed for managing process related events. ISRS8© includes the requirements and learnings from the following process safety standards:

- OSHA 1910.119 – Process Safety Management;
- Seveso II Directive – 96/82/EC;
- Baker and CSB Reports into Texas City;
- ...

## Results

When audited by the DREAL (French environment and industrial risk authority) in December 2001, the Montoir-de-Bretagne LNG Terminal was able to prove that it had established a Safety Management System and fulfilled its obligations under the Seveso II Directive.

During the 2000 decade, by using the ISRS© standard, the French terminals have been progressing constantly (see figure 5).

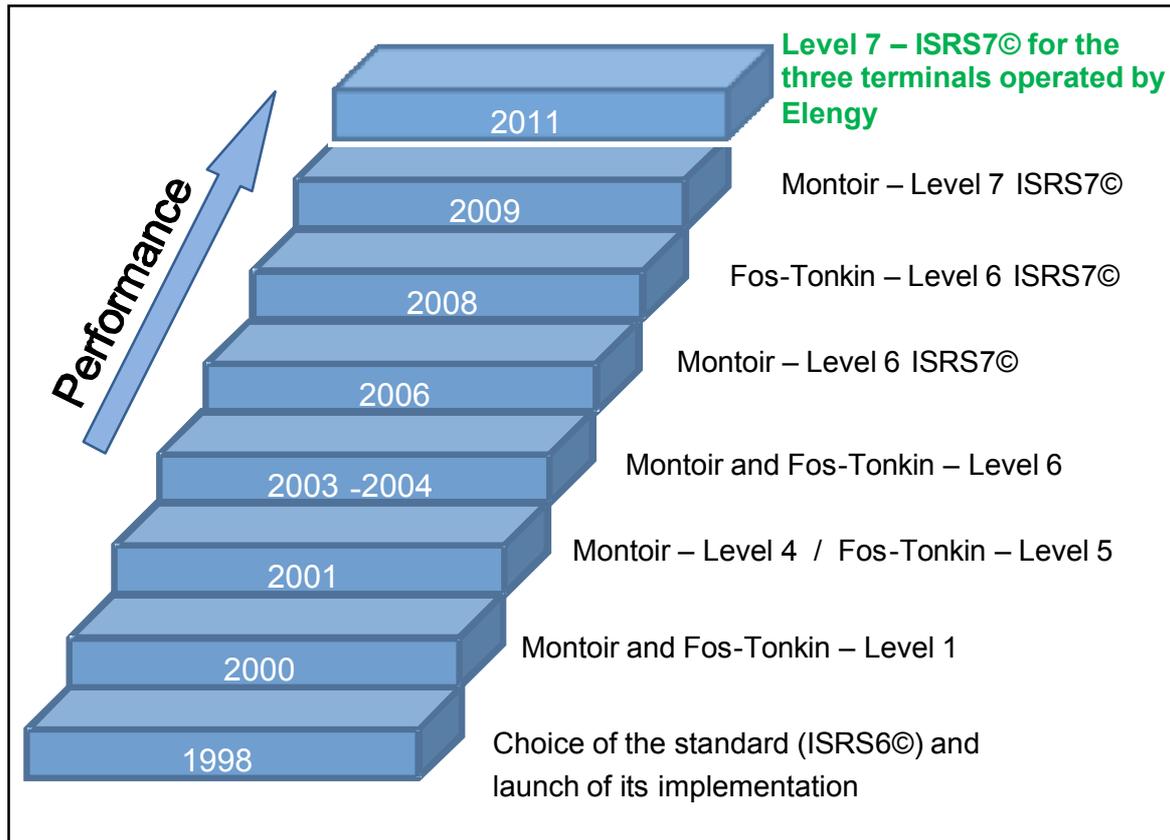
In June 2009, the Montoir-de-Bretagne plant was the first French plant to reach a level 7 ranking under ISRS7©, together with the renewal of its ISO 9001 and ISO 14001 certificates. This followed a 10-day audit that also included an "industrial risk" dimension, through the specific module called Process Safety Management (PSM).

During the 2011 DNV audit of both Fos-Tonkin and Fos-Cavaou LNG Terminals, and as a result the two plants have also been rated at level 7. This audit was a real challenge for the operators of the Fos-sur-Mer Terminals, as the Fos-Cavaou Terminal is in commercial operation only since April, 2010. The choice of a common integrated management system for both Terminals has allowed reaching rapidly this level of maturity, less than one year and a half after the commercial commissioning of the new terminal. The use of the ISRS7© system has been a very efficient tool to transfer knowledge and good practices from the older terminal to the newer one.

These results were achieved during a period of major organisational changes. Ten years ago, the French LNG terminals were operated by regional entities, part of a public vertically integrated company, Gaz de France. After several reorganisations, they are now operated by a small subsidiary, Elengy, of a private international group, GDF SUEZ. The number of customers has risen from one (Gaz de France) to around 20 nowadays. The number of different ships which come to unload their cargo of GNL at the terminal increased in a very important way during the last decade, in connection with the increase of the number of customers.

The integrated management system based on the ISRS© referential has been the point of reference during the last ten years, adding value to plant performance whatever the reorganisations.

Figure 5: Evolution of the ISRS© level reached by the LNG terminals



### Zoom on accidents management

It is often stated that “Good Safety is Good Business”. A good indicator of the performance of a plant is the accident and incident numbers by year. Accident must be here considered as an undesired event leading to a loss. A severity scale, adapted to LNG terminal operations, has been defined to assess the loss whatever its type: lost time accidents, first aids cases, property damage, undesired environmental events, near-misses...

All events are investigated, deeply or not, according to its severity level and likelihood.

As an example, figures 6 and 7 show the number of reported accidents by year for the Montoir LNG terminal. The accidents are classified according to three levels of severity: low, medium and high. It is clear from the chart that the number of accident has been almost continuously decreasing as the safety management system was more deeply implemented. High severity accidents have not occurred for 6 years.

On the other hand, the number of near-misses and unsafe act or condition, the base of the so-called Bird pyramid is also continuously followed up. An effort was made to convince all operators that it is worth spending some time to declare near-misses and unsafe situations. All this information is analysed and action plans are developed to improve the system.

Figure 7 shows the number of reported near-misses and hazardous situations, for the same period as the previous figure. Here, the curve stays at a relatively constant level.

These curves clearly demonstrate an improvement of the safety of the terminal thanks to the commitment of the management and the transparency of the operators of the plants.

Figure 6

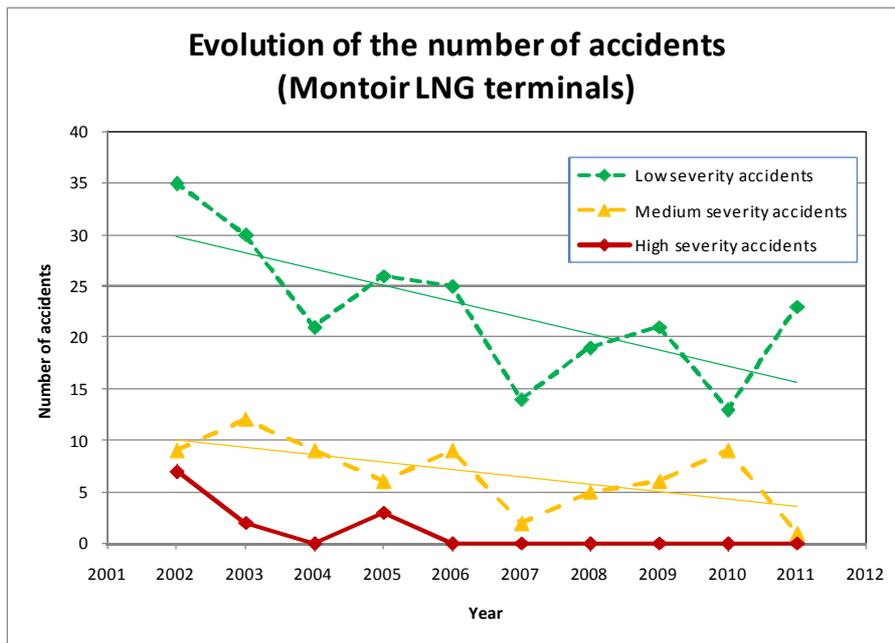
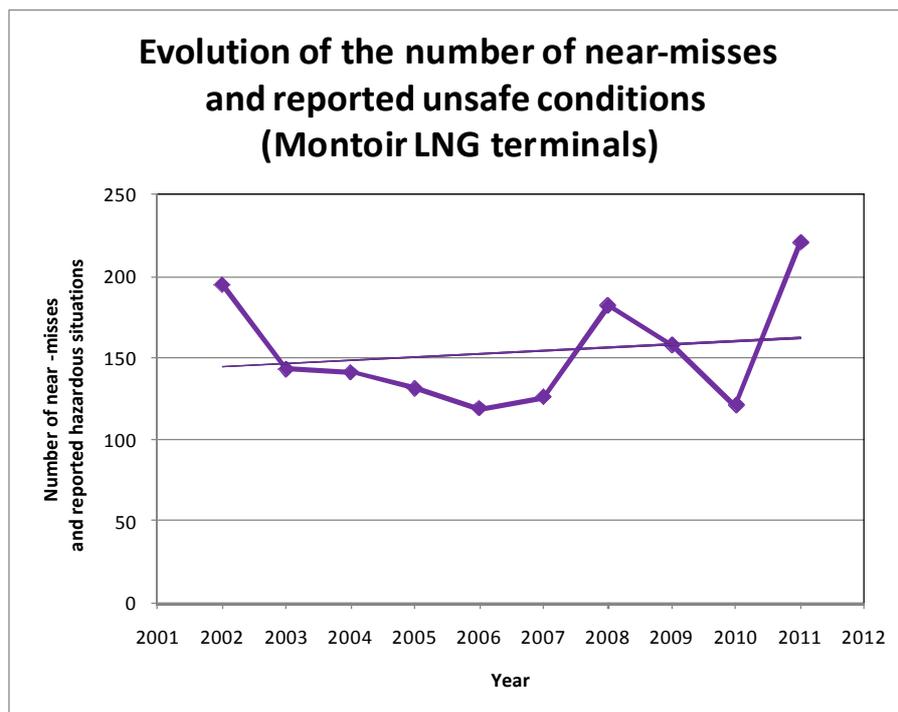


Figure 7



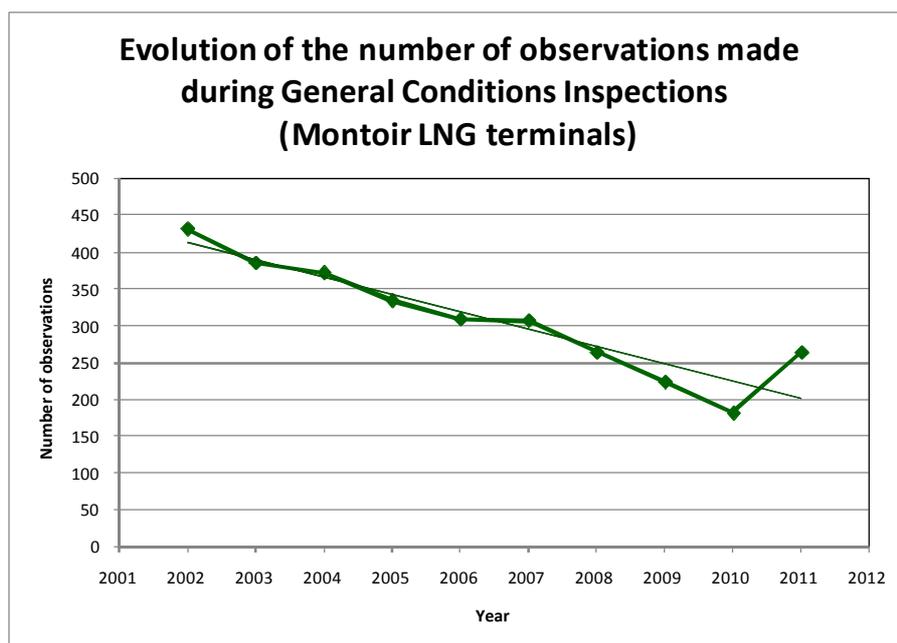
### Zoom on site inspections

Regular inspections ensure that the general condition of the facilities is maintained. A systematic approach is used to divide the plants into geographical sectors, and to conduct inspections of each sector according to an annual planning. Operators responsible for conducting general conditions inspections have received training in inspection techniques.

The completion of inspections is regularly monitored. Necessary corrective actions are identified and followed up using a dedicated action monitoring tool.

At the beginning of the process, the number of observations made during the general condition inspections was relatively high (see figure 8). This number tends to decrease with time and as corrective actions are put in place. Nevertheless, due to aging of facilities, inspections are an endless process, involving the operators, for the benefit of both the safety of the facilities and safety at work.

Figure 8



## Conclusions

The establishment of an integrated management system has not only allowed the plant to obtain the levels of recognition as desired by GDF SUEZ or as mandated by regulation. Above all, it has enabled a better identification of risks generated by the plant's activities, and thus a better control of these risks (including risks from external activities such as purchased equipment or services).

Here is a non-exhaustive list of benefits gained by the French terminals thanks to the implementation of an integrated management system based on the good practices contained in the ISRS7© standard:

- A better control of the activities of the site, in health - safety - industrial safety, but also in quality and environment;
- A better control of the activities of the site and the sub-contracting companies working for the site, thanks to the implementation among others of adapted procedures;
- Successful analyses of accidents, bringing to light the fundamental causes of the events and avoiding their reoccurrence;
- A control of purchases and services allowing a work in safety (selection of subcontractors);
- A comprehensive knowledge of the regulations applicable to the Terminal and the respect for these regulations;

- The implementation of various site visits leads to a greater presence of the plant managers on the site and to visible results as 100% wearing of Personnel Protective Equipment and cleanliness of the site;
- A better knowledge of the emergency scenarios, and a better preparation of the actors.

An integrated management system is also an efficient way to meet the requirements from different standards and regulations (ISO 9001, ISO 14001, Seveso II Directive): a single annual review, a single scoreboard, a single management manual, a single tool to manage all the action plans...

The system creates a continuous improvement loop in which each aspect plays a determining role, and no aspect can be ignored. As a result, everyone becomes involved in the performance of the plant and there is a better coordination and communication between the various actors. The activity of each plant is reviewed, and the LNG Terminal is managed in a more precise manner, greatly increasing confidence in its operation.