

IMPLEMENTATION EXPERIENCE OF ATEX 137 FOR A PETROCHEMICAL SITE

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Directive 99/92/EC (ATEX 137) deals with the safety and health protection of workers potentially at risk from explosive atmospheres (ATEX). Assessments of all existing plants to the new standards were required to be completed by 30 June 2006. This presentation shows the practical experience from a large petrochemical site with the implementation of the Directive and reflects the balance of work completed across a range of areas including:

- Update of existing hazardous area classifications to new standards
- Explosion risk assessment of existing mechanical equipment safety
- Explosion risk assessment of existing electrical equipment
- Explosion risk assessment of temporary work places
- Inspection and maintenance of equipment used in potentially explosive atmospheres
- ATEX training of operators, supervisors and contractors.

The added value of the implementation of the Directive with respect to actual risk reduction and increasing awareness within the organization will be discussed.

The Directive 99/92/EC is better known as ATEX 137 and its aim is to protect the health and safety of workers potentially at risk from explosive atmospheres. The Directive requires an overall assessment of explosion risks and provision of measures to eliminate, prevent or protect against explosions. When completing such a risk assessment the Directive requires that the following considerations are taken into account:

- The likelihood that the explosive atmosphere will occur,
- The likely persistence of the explosive atmosphere once formed,
- The likelihood that an ignition source will be present.
- The likelihood that the ignition source will be active and effective.

By considering the above the risk of ignition actually occurring can be assessed. When this risk is combined with the installation concerned, the substances present and the processes in use, and the possible interactions between them, then the scale of the potential consequential effects can be assessed.

This paper reviews the experience to date of implementing ATEX 137 on the SABIC Europe petrochemical site at Geleen in The Netherlands.

The site has been in existence for many years, with up to 30 years old plants. The site decided to implement ATEX 137 to continuously improve on process safety performance and to maintain regulatory compliance, taking into account cost effectiveness. The key requirement for the site is to assess systematically the explosion risk from the workplaces and the equipment in use, as indicated in Figure 1.

One of the basic principles for successful ATEX 137 implementation is that it should not be perceived as a paper exercise, but as a practical means of raising the explosion safety standards at the site. To assess the possible added value a brief review of recent incidents was completed to identify how the implementation of ATEX 137 could improve site safety. During a 14 month period from 2004 – 2005 there were 97 incidents recorded in the site incident reporting system. Of these it was estimated that 11, or 11%, could probably have been prevented if ATEX standards had been in place, see Table 1.

In order to manage the cost effective implementation of ATEX 137 it was necessary to clearly define the work scope for the project. It was decided to carry out the implementation as a project such that it was completed consistently across the large and complex petrochemical site, and also to optimise resource requirements.

The work scope for the project was as detailed below:

- Establish the best practice for ATEX implementation
- Review Hazardous Area Classification
- Complete an electrical gap analysis for each plant
- Complete a mechanical gap analysis for each plant

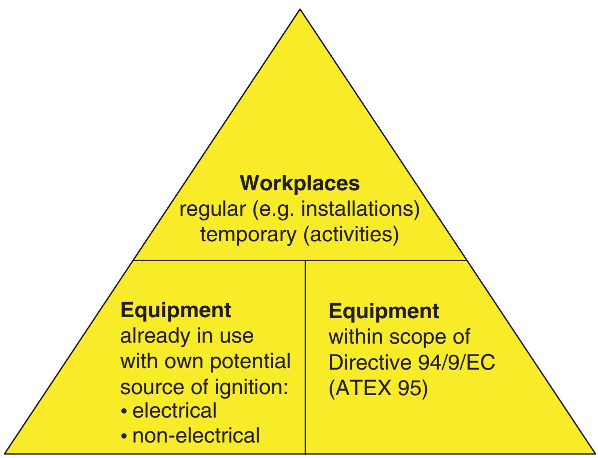

Figure 1. Assessment and evaluation of explosion risks

Table 1. Incidents related to ATEX

Cause of incident	No. of incidents
Temporary workplace	6
Not conscious of working in zoned area	2
Procurement	1
Conformity of design	1
Process failure (in regular workplace)	1

- Develop action plan to address gaps identified
- Complete generic ignition risk assessments for mechanical equipment
- Complete specific mechanical ignition risk assessments
- Carry out an expert survey for other process ignition risks
- Develop training packages
- Deliver ATEX training for selected personnel
- Create explosion protection documents (EPD)
- Include ATEX in job safety assessments (JSA) for temporary workplaces
- Ensure safety, health and environment (SHE) management system includes all ATEX requirements.

This is schematically shown as a flowchart in Figure 2.

As the first step a multidisciplinary team of experts developed the risk assessment methodology for the site. The intention is to align the work processes developed with the SHE management system such that it becomes aligned with the site risk evaluation procedures. This has proved to be more difficult than expected, as ATEX 137 didn't specify residual risk tolerance criteria especially for normal operation.

The starting point was to review the best practice for ATEX, using internal and external resources to define what the site viewed as best practice. This required a variety of experts, and a managed workshop to develop the basic principles for the project team.

SABIC Europe's next action was to agree a way forward with the Dutch Labour Inspectorate. The proposal was to agree on the use of the best practice methodology and to seek agreement for using a mixture of generic and specific ignition risk assessments.

The Labour Inspectorate agreed with the philosophy that for electrical equipment ignition risk assessments (IRA) would only be undertaken if the hazardous area classification (HAC) from the past had changed. Further for mechanical equipment it was agreed that generic IRAs could be used for equipment in zone 2 areas, whereas equipment in zone 0 or 1 would have a specific IRA completed. Other ignition sources would be identified through the use of an expert survey, e.g. to determine hot surfaces and potential electrostatic ignition sources. The focus would initially be on regular work places, including process installations, followed by temporary work places.

The first practical exercise was to review all of the existing HAC assessments to verify that they matched the new HAC standards. The areas of concern which arose were

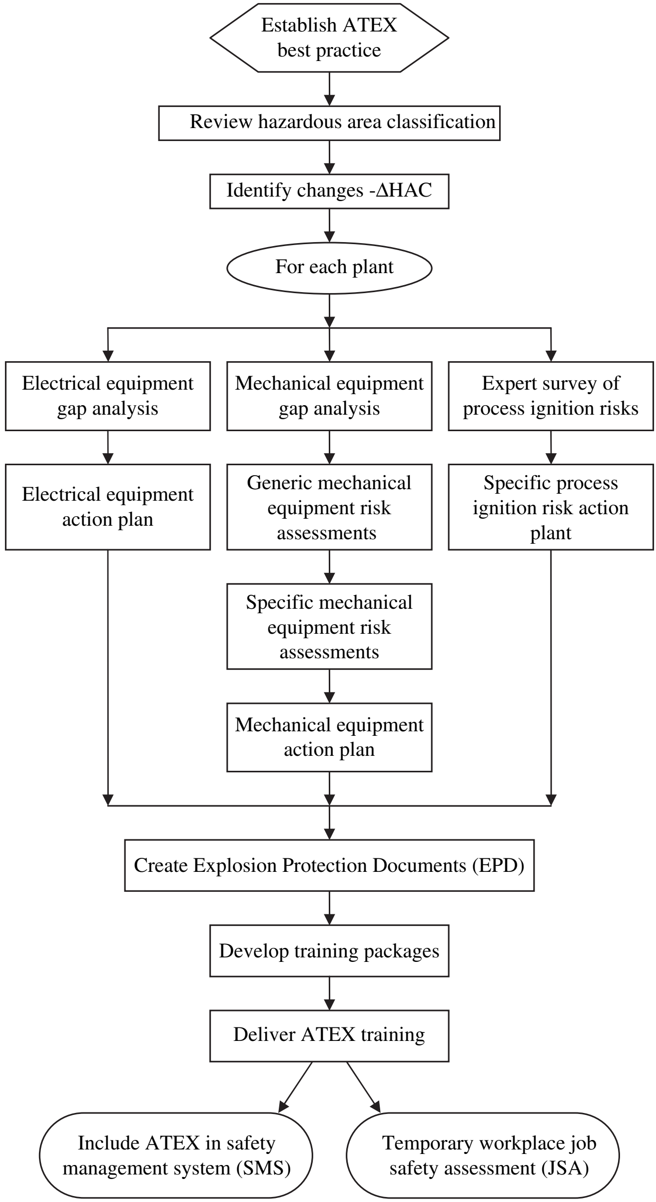

Figure 2. Flowchart for ATEX implementation

dust explosion hazards, vessel internals, ventilation and openings between buildings or into adjacent hazardous areas.

The exercise highlighted how limited the available information is on dust explosion risks, such as minimum ignition energy values, and lead to additional testing on certain materials handled to obtain the correct data for the explosion risk assessments.

The outcome of this changed hazardous area classification (ΔHAC) was a set of pre- and post-project HAC drawings for the site.

Vessels had typically not been internally zoned previously, so for each vessel it was necessary to verify whether there was any electrical or mechanical equipment internal to the vessel which should be subject to a risk assessment. For vessels which were inerted the principle of fault tolerance was used to determine the required reliability of the inerting system to ensure that the vessel remained inerted under all foreseeable process conditions and so was not subject to HAC zoning, in particular where there was a potential internal source of ignition.

The fault tolerance (FT) principle is based on the number of independent faults or system failures that need to occur before the potential ignition source becomes active in the unprotected situation. If an ignition source is not caused by a fault or failure but is inherently present during normal operation, or if the occurrence of the ignition source and the formation of the explosive atmosphere have a common cause, then the FT is −1. If a single fault already leads to an ignition source then the FT is 0. If two independent, simultaneous faults need to occur to give an ignition source then the FT is 1, and so on.

ATEX 137 does not specify acceptable risk tolerance criteria for use in the explosion risk assessments, but a target value for tolerable ignition risk can be derived from the requirements and standards under the ATEX 95 Directive. This Directive indicates that the sum of the fault tolerance (including all protection measures) and zone for the intended use of the equipment shall always have at least the value of two in order to achieve the requisite overall level of protection [Perbal et al., 2006]. To derive the required reliability of the inerting system for a vessel, the sum of the internal grade of release, the fault tolerance of the equipment within the vessel, and the reliability of the independent protection layer(s) (IPL) (expressed as a safety integrity level (SIL)) must equal at least two. An IPL is defined as a device, system or action that is capable of preventing the scenario from proceeding to its undesired consequence, independent of the initiating event or the action of any other layer of protection associated with the scenario. Hence, an IPL shall be effective, independent and auditable. This principle is expressed in Figure 3 and Table 2, and can be used generally for determining either the integrity of the safety instrumented system to be used for the process under consideration (PUC), or the required fault tolerance of the equipment under control (EUC).

In general the ΔHAC did not create too many changes to the existing zones, but due to the considerations of ventilation and openings some areas extended further than previously, in particular through openings or into adjacent hazardous areas. One example was where drive belts and motors for a compressor were located outside a building to separate them in the past from the zoned area. However, now the wall opening is treated as a potential source of release, creating a zone 2 area where the motor and drive belt system

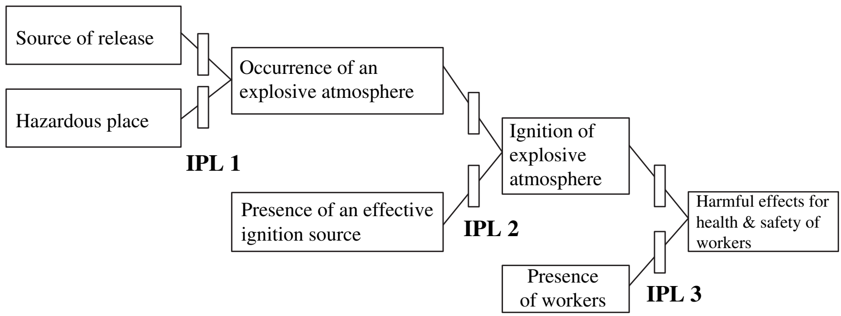

Figure 3. Explosion scenario with independent layers of protection

are located. Another example is within the skirt of a furnace, where the lack of ventilation now requires the area to be zoned as an enclosed space with no natural ventilation, with a risk of release of flammable gas. Again the existing equipment was not specified for the zone 2 now required. Hence, these situations needed a more close explosion risk assessment.

The detailed gap analysis for all changes found by the ΔHAC was split into electrical and mechanical reviews.

For electrical equipment a detailed inspection of areas where the zone had changed was completed. This included areas now zoned which had not previously been, and areas where the zone had increased, e.g. from zone 2 to zone 1. Further the gas group and temperature class ratings of equipment were checked generally, using a random auditing process across all zoned areas as it was not practical to check every piece of equipment. It was generally found that the selection of electrical equipment in the past was very

Table 2. Explosion risk assessment using fault tolerance

Explosion risk assessment	Probability/Frequency	Factor
Formation of explosive atmosphere (PUC[1])	Grade of release: 0/1/2	
IPL 1: preventing formation of explosive atmosphere	SIL: 1/2/3	
Fault Tolerance of equipment present (EUC[2])	FT: −1/0/1/2	
IPL 2: preventing ignition of explosive atmosphere	SIL: 1/2/3	
IPL 3: mitigating harmful effects of an explosion	SIL: 1/2/3	
Sum of factors	Target value ≥ 2	

[1]Process under control (PUC) is the intended operation of the process within the design parameters, in absence of any protection measure associated with the explosion scenario.
[2]Equipment under control (EUC) is the intended use of equipment within the design parameters, in absence of any protection measure associated with the explosion scenario.

good, and due to the previous philosophy of using zone 1 specified electrical equipment as standard, thus even previously less hazardous classified areas were found to be generally compliant.

As expected, some areas for improvement were found, however considering the huge numbers of items of electrical equipment this was not excessive. Only a number of pump motors across the whole site were found to be non compliant and need corrective action. Also cables for intrinsically safe systems were identified as a gap analysis issue, as the cable lengths in use were found to be generally acceptable for gas group IIB based on a typical maximum cable length, but needed further assessment in case of IIC.

An area of concern which was identified was that some installation and maintenance standards for electrical equipment were not effectively implemented with respect to ATEX, which needed to be improved by means of not only theoretical but also practical refresher training. All items of equipment will be checked through the regular maintenance and inspection programmes in which ATEX will be included. The ATEX 137 Directive does not specify requirements for maintenance and inspection, so these have been developed as part of the best practice review.

The mechanical equipment gap analysis was completed to identify what equipment was found in each zone, and hence to assess the extent of the work to complete relevant ignition risk assessments. It was estimated that 95% of mechanical equipment within zoned areas was in a zone 2. The types of mechanical equipment in each zone were listed to determine how to optimise the risk assessments. Most equipment in zone 2 areas could be classified into a generic type. A list of the equipment suitable for a generic ignition risk assessment was drawn up, and the assessments completed for each plant, based on a common standard. The generic ignition risk assessments are listed in Table 3.

For zones 2 generic ignition risk assessments were completed for mechanical equipment operating in gas group IIB and temperature class T3. Where the gas group or the temperature class was higher then a specific risk assessment was deemed necessary. A further 260 specific ignition risk assessments for the whole site are in the process of being completed for mechanical equipment mostly being present in zones 1.

An expert survey of the site revealed various problems with hot surfaces which could act as a potential source of ignition. Typically these were on the polymer plants where high temperature steam is used. Un-insulated high pressure steam pipework could easily have a surface temperature above the auto-ignition temperature (AIT) of the flammable materials in the vicinity. A general policy was implemented to require that for lines in zones 1 the piping is clearly labelled on the plant. In zones 1 these lines are not permitted to be de-insulated during operation. Lines in zones 0 where the process temperature may exceed 80% of the AIT are not allowed without temperature control.

Another identified risk area were oil reservoirs internally heated by steam coils. There is a risk of exposed steam coils igniting oil vapours, so low level switches have been installed to control the ignition risk. A further example is where gas venting via seal pots could release flammable gas. It was decided that such seal pots should have level controls to ensure that there is always a water seal.

Table 3. Generic mechanical ignition risk assessments

Ref.	Generic mechanical ignition risk assessments
01	Pump including stuffing box
02	Top entry mixers
03	Splined drive shaft couplings
04	Centrifugal fans
05	Chain transmission
06	Clutch with friction plates
07	General purpose gearbox with anti-friction bearings
08	Plunger and diaphragm pumps
09	Reciprocating compressors crosshead type with oil circuit
10	Rotary feeder
11	Oil flooded rotary screw compressors
12	Shaft couplings
13	Canned motor pumps
14	Magnetic driven centrifugal pumps
15	Bearings
16	Centrifugal compressors
17	Special purpose steam turbines
18	Dry running screw compressor and roots blowers
19	Hoists
20	Dry running rotary screw vacuum pump
21	Liquid ring type vacuum pump compressor with single double tandem seal and all metal coupling
22	Shaft coupling Eupex generic
23	Rotary positive displacement pumps
24	Side channel pumps
25	V-belt transmissions
26	Pelletizers
27	Catalyst pumps
28	Drum sieves
29	Screw conveyors

Temporary work place risk assessments have proved problematic to resolve adequately. The use of the fault tolerance principle was initially intended to be rolled out across the site, with the permit issuers using the method as part of the job safety assessment (JSA) for the planned work. However this has proved to be too complicated and the technicians and supervisors are not confident in using the technique. As a result the assessment of temporary workplaces in compliance with ATEX 137 is still done on a qualitative basis by means of JSA.

An example of how ATEX 137 has not been fully understood when preparing a JSA is the use of tenting for weather protection. The use of a tent changes the ventilation from good natural ventilation to an enclosed space with poor ventilation. This changes the hazardous area zone within the tent, which therefore changes the risk; but it has been found that this has not been identified through management of change by those involved in the job.

The training for ATEX 137 has been very successful within SABIC Europe, and has been a key focus of the Dutch Labour Inspectorate when auditing the site. The training requirements have been carefully identified for defined groups within the company, especially the ATEX Experts are actively involved in management of change (MOC) and pre-start-up safety requirements (PSSR). These people are identified as key personnel across all plant areas that will have a day to day involvement in ensuring compliance in ATEX implementation. They are the local plant experts who other plant personnel can ask for advice, and are key communicators regarding ATEX. Also the ATEX Expert has a role in ignition risk assessments and job safety assessments for temporary workplace to ensure ATEX compliance.

Linked with the ATEX Experts is the ATEX Committee, who makes overall policy and decisions for the site regarding ATEX implementation, and who have been approving the work done by the ATEX project team. The ATEX Committee's role is to ensure consistency of standards across the site and to approve the revised hazardous area classification assessments. Their role is also to advise the site management of their duties and liaise with the Dutch Labour Inspectorate, external committees and other companies to monitor developments.

The collation of explosion protection documents (EPD) for the site has mainly been completed by external contract personnel, due to the high workload involved, based on a template developed by the ATEX Committee. The need for the EPDs is not viewed positively, as collating the information into one document has not provided any tangible benefit or added value for the operations. The EPD is of use as a compliance auditing document only, and relies on the correct hyperlinks through the electronic record systems.

There has been a significant resource input to the ATEX project on the Geleen site by SABIC Europe. A large number of people have been involved; employees, consultants and contractors; and the project has been running for over two years, with the scope evolving over time. As the urgent or short term aspects are completed the longer term issues are being addressed, especially how to integrate everything robustly into the recently restructured SHE management system.

The benefits of the project have been the raising of the explosion safety standards of the site, as non-compliant risks have been identified and addressed. The training has been very beneficial with a high awareness across the teams, indicated by proactive questioning and feedback.

The Dutch Labour Inspectorate has started auditing on the implementation of ATEX 137 at major hazard sites during the second half of 2007, after following special ATEX training during the first half of the year. They are firstly focussing on roles, responsibilities and training of personnel as well as the actual hazardous area classifications, and have until now been satisfied with SABIC Europe's approach regarding ATEX 137 implementation as no major non-conformances were identified during the two audits completed to date.

The requirements for compliance with the ATEX 137 Directive in Great Britain were covered by the Dangerous Substances and Explosive Atmospheres Regulations (DSEAR), 2002. There were differences in compliance dates for some aspects of the Directive, but in general many of the issues identified in this paper are similar to those found by companies seeking to comply with DSEAR in the UK. Discussions with various contacts has indicated that meeting the compliance dates has often not been fully achieved, and some aspects of compliance are still ongoing within many companies, both in the UK and across Europe.

REFERENCE

Perbal, R., Fernie, L., 2006, Implementation of the ATEX Directive 99/92/EC and a practical methodology for explosion risk assessment in existing plants, 2nd International Conference on Safety & Environment in Process Industry, Naples.