20 Years of DSEAR – A Retrospective View

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The DSEAR legislation was enacted in 2002 and implemented in 2003. Thus, the legislation has now been around for 20 years.This paper considers the effect of the DSEAR legislation on the safe use of flammable and explosive substances in the workplace in terms of what is currently expected against what would have been provided pre-DSEAR. The DSEAR legislation is, however, poorly understood by many, and the implementation of DSEAR is, at best, patchy across various industrial sectors. There has been a number of issues in terms of compliance with the legislation and the available guidance, in particular the complexities of Regulation 7 and the requirement for hazardous area classification and also the failure of many companies to complete a suitable and sufficient risk assessment. In several cases this has resulted in unsafe operations and also the issuing of Improvement Notices by the HSE.

Whilst the general principles of hazardous area classification are well known, it is clear from the author's experience that the application of area classification or zoning is, in fact, poorly understood. In many cases over-conservative zones have resulted in high equipment costs and operational difficulties. In other cases, under-zoning has resulted in potentially dangerous situations.

Introduction

DSEAR was enacted in 2002 and became law in 2003 and thus the legislation has been around for 20 years. Hazardous Area Classification and the requirements to consider the risk on a site handling flammable substances have been around much longer. This paper considers the effect of the DSEAR legislation on the safe use of flammable and explosive substances in the workplace and highlights some of the issues in DSEAR compliance.

The DSEAR legislation[1] is, however, poorly understood by many, and the implementation of DSEAR is, at best, patchy across various industrial sectors. Whilst compliance within the traditional oil and petrochemical sectors is generally perceived to be good, the level of compliance within smaller and non-traditional process industries is less good. This is in part due to a lack of experience within smaller companies, and also potentially due to a lack of Chemical Engineering or other suitably qualified expertise available on site.

There has been a number of issues in terms of compliance with the legislation and the available guidance, in particular the complexities of Regulation 7 and the requirement for hazardous area classification. There have also been failures in some cases to complete a suitable and sufficient risk assessment.

The completion of a suitable and sufficient DSEAR risk assessment which, by its very nature should include the provisions of Regulations 5, 6 and 7 of DSEAR also appears problematical to a number of companies, some of whom do not appear to have grasped the basic principles of Inherent Safety. In several cases this has resulted in unsafe operations and also the issuing of Improvement Notices by the HSE.

Dangerous Substances

In order to understand DSEAR, it is necessary to first understand what is meant by a "dangerous substance" under the legislation. The original definition of dangerous substances comes partly from the ATEX 137 directive [3], and partly from the Chemical Agents Directive [4].

Prior to DSEAR it was common for companies handling flammable materials to have a hazardous area classification in place but no supporting risk assessment nor any consideration of a hierarchy of risk reduction measures. This was certainly the case into the 1980s when the author working as a plant manager can recall having hazardous area classification drawings but no matching risk assessments. The definition of "dangerous substances" used was simply "flammable gases and liquids where there may be a flammable vapour present". DSEAR formalised the definition of dangerous substances initially in the original 2002 legislation but this was broadened in 2015 with the change from CHIP [5] to CLP [6]. The original definition was any substance "*which is explosive, oxidising, extremely flammable, highly flammable or flammable*" regardless of the classification under CHIP.

This was changed to: "*a substance or mixture which meets the criteria for classification as hazardous within any physical hazard class as provided for] in the CLP Regulation, whether or not the substance is classified under that Regulation*" (DSEAR Reg.2a) plus the following catch-all "*a substance or mixture which because of its physico-chemical or chemical properties and the way it is used or is present in the workplace creates a risk,*" (Reg.2b) and now specifically mentioning dusts: "*any dust, whether in the form of solid particles of fibrous materials or otherwise, which can form an explosive mixture with air or an explosive atmosphere*" (Reg.2c).

This is further expanded to: " *"hazard" means the physico-chemical or chemical property of a dangerous substance which has the potential to—*

- *(a) give rise to a fire, explosion or other events which can result in harmful physical effects of a kind similar to those which can be caused by fire or explosion; or* *(b) be corrosive to metals,*"

(a) above has been deemed by HSE to include gases under pressure e.g. compressed gas cylinders which, if overheated my explode.

The broad definition of "dangerous substances" appears to have caused issue with a number of companies who have not included corrosive materials (acids) within the DSEAR assessment nor considered the potential for gas cylinder explosions. This has led to DSEAR risk assessments which do not include e.g. storage of inert gases in cylinders which are typically at pressures up to 300 barg. Similarly, materials handling corrosive substances e.g. plating shops now have to consider corrosive properties of materials per se as well as the potential for generation of hydrogen from the plating process.

Example Issues

As a process safety consultant, the author has come across numerous DSEAR issues, some of which tend to fall into the following categories:

- Failure to identify hazardous substances, in particular, explosible dusts and acids;
- Inadequate risk assessment;
- Failure to consider or implement Reg.6 hierarchy of risk reduction measures;
- Incorrect hazardous area classification

Example 1: A DSEAR assessment was carried out for a facility which had a 30,000 litre Diesel tank and dispenser for company vehicles and fork lift trucks. The DSEAR assessor put a 3m Zone 1 around the tank vent and a 5m radius Zone 2 around the tank bund. The Zone 2 crossed a main site road used for access to all areas of the site. Diesel fuel has a flashpoint of >56°C and is not, therefore, flammable at UK ambient temperatures.

Example 2: A large dust filter was installed on a vehicle grit blast facility. The filter was installed without an explosion relief panel which was noted during a periodic DSEAR re-assessment for the site. It was asserted by the site that the dust was not explosible. An action was placed on the company to have a sample of dust from the filter tested for explosibility. The sample tested gave a Kst value of 70 bar.m/s in a 20 litre sphere and a MIE of 40mJ. An explosion panel was subsequently installed.

Example 3: A large company outsourced DSEAR assessments to a facilities management company, who further outsourced the work to a fire protection company who outsourced again to a NEBOSH qualified former firefighter (one-man company). This final contractor used a tick-box form approach to DSEAR compliance which failed to identify a number of significant issues on the facility. The tick-box form also did not adequately cover non-conformances, nor prioritise recommendations for improvement. The form also did not give sufficient information regarding either the risk assessment or the hazardous area classification. The assessment had to be re-done by a competent person.

Example 4: HSE visited a company handling quantities of solvents and the DSEAR assessment done in-house failed to properly define the extent of zoned areas. The DSEAR risk assessment was also deemed inadequate. It was clear that the company had insufficient technical knowledge to carry out the assessment and HSE issued an Improvement Notice. A specialist process safety company was then employed to complete the work.

Implementation in Industry

Implementation of DSEAR has been patchy with some industries being quick to implement the regulations but others being considerably slower, with some companies still not having completed DSEAR assessments. Predictably, the oil, gas, bulk chemical and traditional process industries have generally completed full DSEAR assessments, as have major gas users. The level of DSEAR compliance is considerably lower within the non-traditional process industries, in particular smaller companies where there is little or no in-house Chemical Engineering support. Many of these companies have a single person responsible for all Health, Safety and Environmental issues (slips, trips and falls as well as process safety) who will typically have a NEBOSH [7] qualification but may well have no formal Chemical or Chemical Engineering training.

This is a significant issue in those smaller companies who may rely heavily on advice from external consultants or the HSE. Another key point is the lack of general HSE resource which means that many smaller non-COMAH companies are only visited in the event of a RIDDOR [8] reportable accident. There is also an increasing reluctance to speak to HSE due to the charging regime which sees all advice or site visits being chargeable, currently at £163 per hour.

From observation, the main reasons for the failure to implement DSEAR generally appear to be related to a lack of understanding of the applicability of the legislation to their particular materials and processes and a belief that DSEAR only applies to the chemical industry and fuels. Once again, this appears to be a particular issue with smaller and non-traditional process industries. It is difficult to identify the reasons for the lack of understanding, but it is possible that a high workload in dealing with day to day health and safety may obscure the requirement or importance of carrying out a DSEAR assessment.

Compliance with Legislation and Guidance

Compliance with the legislation is, of course, compulsory, but in some cases the legislation is not totally clear to those outside the legal profession! The HSE have published two Approved Codes of Practice (ACOPs) which are intended to assist in DSEAR compliance. These are L138 [10] (general advice) and L133 [11] (unloading of petrol tankers). These ACOPS hold a special place in law in that in the event of an incident and subsequent prosecution guilt will be assumed if the guidance in the ACOP has not been followed, unless it can be proven that an equivalent or better level of protection has been provided by other means. This is obviously somewhat different to the normal UK law where one is innocent until proven guilty.

The ACOPs recognise the place of standards and sector guidance as providing evidence that best practice has been followed and hence the DSEAR standards, and guidance such as that from the Energy Institute and IGEM should be taken into account. The sector guidance often provides detailed engineering advice on providing a safe design of plant and a safe system of working and hence should be consulted when making a DSEAR safety case. Both the Energy Institute and IGEM make specific reference to DSEAR within their guidance. Other sector guidance is available including for aerosols and LPG.

Key Compliance Issues

Major issues with DSEAR compliance can generally be categorised by lack of compliance with the three key regulations, these being:

5.—(1) Where a dangerous substance is or is liable to be present at the workplace, the employer shall make a suitable and sufficient assessment of the risks to his employees which arise from that substance. [Carry out a DSEAR Risk Assessment]

Regulation 5 is probably the most important as it is a legal duty in the UK to ensure that risks to personnel are As Low As Reasonably Practicable (ALARP). Thus, not only must the hazards be considered but also the potential consequences and personnel who may be affected. The risk assessment must also take account of Regulation 6 (see below).

6.—(1) Every employer shall ensure that risk is either eliminated or reduced so far as is reasonably practicable. [Implement a hierarchy of Risk Reduction measures as defined in Reg. 6]

Regulation 6 is an implementation of the principles of Inherent Safety as so often espoused by the late Trevor Kletz, [12. 13. 14] starting with "if you don't have it, it can't leak [or burn]" and ending with PPE. The implementation of this should be relatively straightforward and is a key factor in the demonstration of ALARP, but in practice it appears that it is often neglected completely within a DSEAR assessment, or at least not clearly documented.

7.—(1) Every employer shall classify places at the workplace where an explosive atmosphere may occur into hazardous or non-hazardous places [Hazardous Area Classification]

Regulation 7 can be described as a form of risk assessment which identifies the extent and persistence of a potential flammable atmosphere. This is the regulation which gives the most issues in terms of the estimation of flammable zones. The process of hazardous area classification has been known for many years but there remains relatively little guidance on how to go about the process and some of the guidance is excessively complicated. The primary sources of guidance are:

- BS EN 60079-10-1 (gases & vapours) [15]
- BS EN 60079-10-2 (dusts) [16]
- IGEM/SR/25 [17] (natural gas) plus a number of other IGEM publications relating to specific applications e.g. venting of natural gas
- EI15 [18] (generally applicable to the energy industries)

There are several possible methods for Hazardous Area Classification, the simplest being the Direct Example approach. This is possible where there is a similar situation within the area classification guidance.

60079-10-1 offers basic guidance, but this is often complex and contains a few illustrative direct examples. The guidance for calculation of ventilation has a "health warning" from the UK and is indeed lacking in a hard scientific basis. A full examination of this is outside the scope of the current paper but sufficient to say that this standard is not all that it could be in terms of area classification guidance. It should be noted that this standard is not adequate for Hydrogen gas as it does not adequately assess buoyancy driven flows.

60079-10-2 offers basic guidance for dust zoning with again a limited number of examples. The examples are, however, generally helpful and widely applicable within the dust and powder handling industries. Where 10-2 lacks is guidance relating to common items such as bucket elevators and pneumatic conveying systems.

IGEM/SR/25 offers a wide range of guidance for natural gas systems at a range of pressures. These are generally helpful but once again ventilation guidance is somewhat complex. Other IGEM publications cover e.g. venting of gas

EI15 offers a variety of guidance which is applicable to the energy and related industries. This includes examples on fuel loading to tankers and large storage tanks. The list of materials is generally limited to common fuels e.g. LPG, Gasoline, Diesel plus Refinery Hydrogen. Note that Refinery Hydrogen is hydrogen plus other hydrocarbons

Other methods include Risk-Based approach, Gas Dispersion Modelling and CFD. All of these methods are time consuming and should only be undertaken by someone who is suitably qualified and experienced. The risk based approach is detailed in EI15 and can be useful where there is no other suitable guidance. Gas dispersion modelling is a technique which can be applied using software such as PHAST [19], however, great care must be taken to identify the source term for the release and account for any environmental factors which may affect the dispersion model. In practice, it will generally be necessary to model a number of scenarios in order to identify the worst case for dispersion. PHAST was used to verify the size of zones for the 4th Edition of EI15.

CFD is complex and potentially expensive and should only be considered as a last resort where no other guidance can be reasonably applied e,g, complex releases in confined spaces where there may be limited ventilation and obstructions. The cost and complication of CFD should be compared against the cost and safety implications of using a blanket zoning approach and the elimination of foreseeable ignition sources within the area.

In all cases, area classification examples are based on equivalent to "good ventilation" although the definition of what constitutes "good" differs between various guidance documents. In practice, a loose definition is "equivalent to outdoors", but this may vary based on wind speed, atmospheric turbulence etc. For indoor ventilation this may be deemed as equivalent to between eight and twelve air changes per hour for a compartment.

Ventilation

Whilst assessment of outdoor ventilation is not generally problematical, the assessment of indoor ventilation is somewhat more convoluted. Outdoor ventilation may generally be deemed as "good" unless there is congestion or some form of obstruction to air flow. Since most common vapours are heavier than air, the presence of pits, depressions and bund walls must, of course, be taken into account.

For indoor ventilation, both the rate and availability of ventilation must be taken into account. One other key factor in indoor environments is the distribution of ventilation. Thus, in a compartment, the location of the exit ventilation must take account of gas or vapour density and location of air inlets. This must be designed such as to eliminate dead zones or areas of recirculation within the compartment.

One common issue with ventilation is that extraction vents are often located at roof level within the compartment where the hazard is from a dense gas or vapour. The author has seen this on a number of locations where large quantities of flammable solvents were stored. Turning this around, there have been UPS rooms with risk of hydrogen generation where the vent is at low level. One important factor is ensuring that there is, in fact, through flow of ventilation. The author has come across a number of locations where extraction fans are fitted but there is no air inlet and thus no air flow, possibly the worst being a pump room operating with extremely flammable solvents (flashpoints below -20°C) and pump pressures of 12 barg where dual extract fans were installed with auto-changeover but no air inlet to the compartment. The level of suction was such that it was difficult to open the door into the compartment.

Another issue is blanking of compartment ventilation louvres where ventilation louvres have been blocked for "fire protection" purposes leaving no make-up air to a compartment. This has been observed in several locations including on large UPS facilities giving the risk of explosion within the compartment.

BS EN 60079-10-1 2015 edition changed the approach from the degree of ventilation to a "degree of dilution". A full discussion of the scope of the calculations in the standard is outside the scope of this paper but suffice to say that use of the standard for ventilation may give unrealistic results. In general, compartments with multiple release sources e.g. flanged and screwed connections may generally be assumed to be a Zone 2 area based on the potential for a release from any given flange. This approach will minimise the risk of explosion or fire within the compartment. This is again a situation where good engineering judgement may provide a better basis of safety than the guidance.

In all cases not only should the ventilation flow and coverage be considered but also the reliability of any ventilation system, especially forced draft systems. This is especially important where the availability of ventilation is a fundamental part of the Basis of Safety for the area. Where this is the case then a single fan is unlikely to meet the reliability criteria and a dual fan system with auto-changeover may be required. Where reliability is critical then a SIL assessment may be required.

Area Classification Quantities

One common question is that of the minimum quantities where hazardous area classification should apply. 60079-10-1 does not give any guidance on this. For liquid above the flashpoint EI15 gives 25 litres indoors and 200 litres outdoors as the threshold for hazardous area classification. The caveat within EI15 is "*for inventories below these values, it is up to the user to determine the extent of hazards and necessary safe distances. These figures rely on the use of good practice. It is up to the user to determine the extent of hazard for the materials being stored and handled on the premises*". Once again it appears that "engineering judgement" is required, and, of course, this is subject to "good ventilation".

It should further be borne in mind that the Energy Institute generally deals with bulk containers e.g. 200 litres and above, whereas other industries may have large quantities of smaller sized containers. This guidance does not make any allowance for the size of container. For example, would area classification apply to 200x 1 litre bottles in the same way that it would apply to 1x 200 litre container? E.g. the warehousing industry and personal care products sector may have a large number of containers of 1 litre and less, stored in boxes for transhipment to customers. It seems relevant to make consideration of the maximum potential release quantity as well as the overall quantity stored in any area.

It seems reasonable to consider not only the material flammability properties and the absolute quantity in storage, but the storage container size when taking into account the risk of a significant loss of containment. This is another area which is not covered in any of the guidance but which often causes issues with area classification.

General & Sector Guidance

There are some cases where the area classification guidance documents listed above are not in compliance with guidance for similar installations as provided by the specific industrial sector technical bodies. In particular, this can be seen for LPG tanks where the zoning given in EI15 is considerably different from the zones provided by at least one major supplier of LPG. In addition, some of the sector guidance does not appear to match 60079-10-1 methodology for zone estimation.

For example, sector guidance for LPG tanks indicates a zone 1 around the screwed drain connection on the bottom of the tank whereas this being a secondary source of release as defined in 60079 and being in a well ventilated area would indicate that this should be a zone 2. There are other similar examples e.g. the connection to the tank during filling is shown as a

1.5m radius zone 1 extending to ground level whereas this is shown as a 0.5m radius zone 1 in the sector guidance. In general, if appropriate sector guidance is available showing a direct example then this may be preferred over the generic approach taken in 60079-10. This is, however, a case where engineering judgement may need to be applied.

When to Area Classify and the CLP Conundrum

EI15 gives clear guidance for liquids that hazardous area classification should be implemented if the material is within 5°C of the flashpoint in storage or is heated to within 5°C of the flashpoint during processing. EI15 also lists “fluid categories” which give an indication of when area classification would be required. Bearing in mind that DSEAR is UK legislation, it is written for the temperate climate of the UK, i.e. with a typical maximum air temperature of approximately 33°C (allowing for 2022 maxima of 40°C).

The CHIP regulations assigned “categories” for liquid fuels based on the flashpoint based on the level of hazard. Thus, high hazard materials were those with a flash point < 0°C and an initial boiling point ≤ 35°C (Category 1). Medium hazard materials were those with a flash point < 21°C and not classified as “extremely flammable” and the lowest risk “Category 3” materials having a flash point ≥ 21°C and ≤ 55°C. Thus, Diesel and similar fuels having flashpoints >56°C were excluded from the CHIP hazard categories and designated “Low Hazard”.

The CLP “Globally Harmonized Standard” changed the category 3 upper flashpoint limit to ≤60°C thus bringing Diesel fuel into CLP Category 3. This change has caused great confusion among those people having a lesser understanding of hazardous area classification and resulted in Diesel fuel being zoned in storage and use when it is well below the flashpoint.

The HSE website gives the following guidance:

“*… many substances so classified [as flammable under CLP] may in fact not normally present a significant risk of fire as stored. Employers should adopt a proportionate approach in considering whether there are any justifiable further measures needed in addition to those widely used before this change, given that the risk itself has not changed*.”

Numerous organisations appear to have completely misunderstood that the CLP fuel categories relate only to the labelling for storage and transport of materials and have no relationship to hazardous area classification. This misunderstanding has been promulgated by at least one well known fuel pump and dispenser supplier. The result of this has been increased cost in the installation of ATEX equipment where it is not required. The author would generally agree with the EI15 criteria of within 5°C of the flashpoint which would give the following table for some common substances:

Material	Flashpoint	Zoning
LPG	-104	Always zone
Gasoline	-44	Always zone
Ethanol	12	Always zone
Kerosene / Jet A1	38	Always zone unless it can be guaranteed that temperature will not exceed 33°C
Diesel / Gas Oil	>56	Don’t zone unless heated to within 5°C of the flashpoint
Aniline	70	Don’t zone unless heated to within 5°C of the flashpoint

In consideration of common materials within the UK, the more difficult ones are those with flashpoints of around 40°C e.g. Kerosene / Jet A1. Generally, unless it can be guaranteed that the air temperature cannot exceed 33°C then it would be prudent to area classify. Secondly, if stored in above ground storage tanks, or within the fuel tanks of an aircraft, then solar gain may give metal temperatures >50°C.

For Diesel and similar fuels then unless there are extremes of temperature and direct solar impingement on the containment then hazardous area classification is not necessary. In practice, there are few materials with flashpoints in the region of 40-45°C where the decision to area classify or otherwise is unclear. These criteria apply to the UK and similar temperate regions and will differ e.g. in sub-tropical or equatorial regions.

Fuel Misting & Area Classification of Mists

Fuel mists can be ignited at conditions outside the normal envelope for vapours, in particular, at temperatures below the nominal flashpoint and concentrations above the Upper Explosive Limit. Conventional industry practice has been that fuel mists were not an issue at pressures below 8 barg as it was not generally possible to generate a stable mist at pressures below this pressure.

In 2009, the UK Health and Safety Executive (HSE) published a review of serious incidents involving ignition of flammable mists of high-flashpoint fluids which was presented at Hazards XXI in 2009[17]. The survey showed that over a 50 year period most mist explosions were as the direct result of the deliberate generation of mists. One particular series of incidents occurred during the fumigation of houses in the USA where a fuel oil mist was used to carry the fumigant into the property. The most probably cause of ignition in these cases being non-isolated electrical equipment. The other common source of mist explosions was during the filling or cleaning of large ship oil tanks where mist is created during splash filling or else cleaning operations. The most common source of ignitions identified in this case being electrostatic discharge.

A considerable amount of effort has been expended attempting to quantify the flammability of fuel mists, especially those relating to high flashpoint fuels [18]. It should, in any case, be noted that fuel mists are generally only an issue for high flashpoint fuels as low flashpoint materials will rapidly generate quantities of flammable vapour if released in atomised mist form. 0A Joint Industry Project[19] has carried out experimental work on a range of fuels and results have been published previously at Hazards conferences and other places.

Mists are relatively easy to generate at pressures >1 barg using a nozzle specifically designed to generate small droplet sizes. Based on many tears industrial experience and accident records, it is, however, by observation, extremely difficult to generate a mist from the type of releases found in typical industrial equipment.

Mist explosions occur infrequently in steel mills due to leaks of hydraulic fluid in mill equipment, however, the extreme temperatures in the steel making process, often >1,000°C, will ignite almost any hydrocarbon fluid and therefore mist explosions may be mis-identified as leaks or sprays which are then ignited by contact with hot metal. In any event, these are very rarely a hazard to personnel due to the location of the equipment.

There were, however, only two verified identified process industry mist explosions identified over the period of the survey. On this basis it can be concluded that the risk of mist explosions within the process industries, including fuels, is extremely low and can generally be disregarded within DSEAR unless mist is formed intentionally within the process. In particular, high flashpoint materials such as Diesel fuel, hydraulic fluids and lubricating oils are very unlikely to form a flammable mist and that the risk of mist explosions is generally negligible in industrial situations.

Area Classification for Mists

The guidance for area classification of fuel mists is both sparse and vague, and, in the author's opinion, over-pessimistic both in terms of frequency and extent of the possible mist cloud. This is a particular area of concern since it may lead to over-zoning and the area classification of areas where zoning is not a reasonable basis of safety or may incur excessive equipment costs to provide ATEX equipment. In practice there is currently no credible accurate guidance for the estimation of mist zones. Indeed, there is no adequate guidance as to the assessment of the risk of mist formation other than during splash filling of tanks.

The APEA Blue Book for the design of filling stations is a particular culprit in respect of over-zoning for mists. It is cautioned that the mist zones, especially those related to Diesel fuel filling of road vehicles shown in this particular publication, should be treated with extreme caution. It appears that the zones for this have no credible scientific basis as they extend over parts of the vehicle where the temperature may be expected to be above the autoignition temperature of Diesel and there may be electrical ignition sources present.

Given the current approach to this issue it would be very easy to get led "down a rabbit hole" into over-cautious zoning of facilities where the risk of fire or explosion is, in fact, negligible.

Transient Zones

Transient zones are those which are present only during specific periods. Examples of these are:

- Drum & IBC filling
- LPG tank filling
- Road tanker offloading

Transient zones are in place during the specific operation and unless there is a loss of containment during the operation will be cleared once the operation is complete. These zones are based on the probability of release during the operation e.g. hose connections are classified as a primary source of release due to the potential for leakage from the connection. Where a zone is transient this should be noted on the area classification report and diagram.

Carrying Out a DSEAR Assessment

For new facilities, a DSEAR assessment should be carried out at the design stage based on a preliminary layout. This will identify zones and where ATEX equipment is required. A pre-commissioning inspection should be carried out prior to the commissioning of any facility having zoned areas under Regulation 7(4) of DSEAR:

7 (4) Before a workplace containing places classified as hazardous pursuant to paragraph (1) is used for the first time, the employer shall ensure that its overall explosion safety is verified by a person who is competent in the field of explosion protection as a result of his experience or any professional training or both.

In all cases, the completed DSEAR assessment should consist of:

- DSEAR Risk Assessment (Reg.5)
- Consideration of the hierarchy of risk reduction measures in list order (Reg.6)
- Hazardous area classification (written description and diagrams) (Reg.7)
- Consideration of other DSEAR regulations e.g. signs & labelling, duty of co-ordination

The DSEAR report should clearly identify any areas of non-conformance or defects found and also make consideration of the level of severity of these. Area classification drawings must, of course, have clearly identified zones marked along with key zone dimensions. A full scaled CAD drawing is not necessary, but it is essential that the drawings can be taken on plant and the extent of the zones be clearly identified.

Additional Factors in a DSEAR Assessment

In addition to carrying out a simple hazardous area classification and DSEAR risk assessment, consideration should be made of the type and condition of equipment installed within the hazardous areas as that is a key part of the basis of safety for zoned areas. Thus, it is essential that anyone carrying out a DSEAR assessment should have a basic knowledge of protection methods and the type of equipment installed in zoned areas and required by the EPS [20] Regulations.

The author has personally come across numerous examples where the electrical installation is unsuitable for the area, in particular, the following faults:

- ATEX electrical items connected by non-ATEX wiring;
- Mixture of ATEX and non-ATEX items;
- Zener barriers & power supplies inside zoned area;
- Damaged or modified ATEX equipment;
- Portable non-ATEX electrical equipment.

Whilst a full COMPEX inspection would not be expected, the DSEAR assessor should be able pick up obvious issues such as the above during a hazardous area classification process.

Laboratories & Small Pilot Plants ("Kilo Labs")

This is another area which is often neglected with many laboratories not having completed DSEAR assessments, the main reason for this from experience being that they "only handle small quantities" [of DSEAR dangerous substances]. For small laboratories, it may indeed be true that the quantities of dangerous substances are indeed below a ;level at which hazardous area classification would be required, however, this does not remove the requirement for a DSEAR assessment, nor the identification of a valid Basis of Safety for operation.

DSEAR for laboratories and small pilot plants (>5kg, often known as "kilo labs") is complicated by the nature of activities which may include means of heating e.g. Bunsen Burners or electric heating mantles as well as exothermic and / or violent reactions. ATEX laboratory equipment is not generally available and hence an alternative basis of safety is required.

The HSE website has a Laboratory Safety Guide which has basic advice for compliance which includes the use of flammable gases and fume cupboards, and a restriction on the total quantity of flammable materials stored of 50 litres. This is generally good practice, but does not take into account e.g. large teaching laboratories where there may be more than 100 operational benches and fume cupboards.

This is something of a simplification as a typical Winchester bottle contains 2.5 litres of liquid and common flammable laboratory chemical provided in Winchesters include Acetone, Methanol and Toluene as well as highly flammable materials such as Cyclohexane, Propanol, Butanol etc.

Given that hazardous area classification is not practicable for laboratories then the Basis of Safety for operation must be:

- Storage of only the quantities immediately required for work in the laboratory
- Minimisation of quantities used in experiments
- Larger quantities stored outside the workplace
- Control of quantities in use and maximum container sizes
- Storage of hazardous materials in COSHH cabinets when not in use
- Use of fume cabinets which should have secondary spill containment
- Control of ignition hazards
- Risk assessment of the hazards of the processes being carried out
- Emergency planning & personnel training

In addition, the use of gas taps, Bunsen burners and other strong sources of ignition should be carefully controlled.

Small scale pilot plants may typically use up to 5 kg of materials within the process. At this scale equipment used is often glass which is susceptible to both impact and thermal shock damage. This coupled with the frequent use of elevated temperatures e.g. reflux or distillation processes means that a specific risk assessment is required for kilo scale pilot plants, which may not include a hazardous area classification but must be in accordance with DSEAR Regulations 5 and 6..

Pilot plants of >20 litres will generally be subject to hazardous area classification in the same manner as production plants. In this case, hazardous area classification and ATEX equipment should be in place within the pilot plant which should generally be separated from other manned areas by fire resistant walls and doors. Pilot plants of >5 litres capacity will, in general be constructed from steel and therefore the potential for leakage and general loss of containment will be similar to production plant equipment.

DSEAR Qualifications

Firstly it is necessary to separate COMPEX qualifications which relate to the installation, maintenance and inspection of hazardous area equipment from being a Suitably Qualified and Experienced Person to carry out a DSEAR assessment. COMPEX and IECEX qualifications for installers and inspectors are well known and defined. These are, however, not relevant to the process of carrying out a DSEAR assessment being purely equipment oriented.

This is a difficult subject and at the time of writing there is no clear answer. There are many companies which offer DSEAR training and which training may be formally identified as qualifying for CPD, and whilst these courses usually offer completion or attendance certificates they do not guarantee that the delegates are SQEP on completion.

Consideration of the knowledge required to carry out a DSEAR assessment would include knowledge and understanding of:

- Basic flammability concepts
  - Flammability Limits, Minimum Ignition Energies etc
- Material properties
  - Density, vapour density, volatility
- Gas dispersion
  - Behaviour of dense, buoyant and neutral plumes
  - Effect of ventilation
- Release sources & frequencies
- Experience of industrial operations

Whilst it may appear relatively simple to train someone to be SQEP in DSEAR, the reality is that DSEAR competence is a combination of knowledge and experience which cannot be properly gained within the confines of a training course.

DSEAR Training

There are numerous DSEAR training course which are offered by a range of training companies. Training varies from low cost on-line courses to expensive multi-day training. These courses are almost universally generic in content and rely heavily on HSE ACOP L138, BS EN 60079-10, EI15 and IGEM/SR/25. This generic training may have considerable content, but is generally limited to the industry examples in the above guidance and is often not relevant to specific industries or sectors.

Whilst this approach will provide a degree of competence, many of the companies who need DSEAR training will not be in the industries covered by EI15 or IGEM guidance and therefore the training may be of limited application in e.g. the batch chemical or pharmaceutical sectors. A more directed approach to training where the course relates to the specific industries from which the delegates originate, and utilising more relevant examples would offer significantly more value to the majority of delegates./

DIY DSEAR

A number of companies have attempted to do DSEAR assessments using internal resources. This has predictably resulted in some highly inaccurate and in a number of cases dangerous DSEAR assessments. These DIY assessments have mainly been performed by smaller companies who have limited resources and do not wish to employ an external consultant, potentially due to cost and potentially due to a misguided belief that DSEAR compliance is simple. DIY DSEAR assessments are often carried out by someone inexperienced in hazardous area classification and with insufficient qualifications to be considered SQEP. A NEBOSH qualification is insufficient to complete a DSEAR assessment.

One reasons for doing the assessment in-house is obviously cost, as the employment of an external contractor can be both time consuming and expensive. It may also be difficult to assess the competency of external contractors, more of which below.

Competency of Consultants & Contractors

The complexities of DSEAR mean that many consultancies and contractors have seen business opportunities. Whilst there are many consultants offering good services, there is, unfortunately, a significant number who are not suitably qualified or experienced to carry out a DSEAR assessment. This issue has been compounded by the number of companies, in particular smaller ones, who are not “intelligent buyers”. In a small but significant number of cases HSE have issued Improvement Notices for DSEAR following site visits.

All contractors and consultancies have a responsibility not to step outside their area of competency. It is, however, clear that either financial gain or an over confidence in ability has over-ridden the responsibility to provide a competent and accurate DSEAR assessment and yet continue to offer the service. Unfortunately there is little or no policing of DSEAR compliance outside COMAH sites by HSE and thus there are numbers of poor quality DSEAR assessments still being produced.

As noted previously, it can be difficult to assess the competency of a consultant when looking to have a DSEAR assessment carried out, and a flashy website is not an indication of competency of personnel. Another caveat is that there are companies which advertise a wide range of services but who employ “generalist” Chemical Engineers rather than specialists. Again, these should be treated with caution and the competencies of the individual engineer carrying out the work should be ascertained.

Conclusions

The implementation of DSEAR within the non-traditional process industries remains patchy, both in the quality of the assessments, and in that a number of companies have not completed a DSEAR assessment despite storing and using significant quantities of DSEAR dangerous substances. This is both a failure in communication of the legislation and a direct result of the lack of suitably qualified personnel within the process industries generally.

The process of hazardous area classification remains unclear and difficult to implement in several respects, especially with regards to the effects of ventilation in confined areas. The accuracy of hazardous area classification reports and drawings is a continuing cause for concern. The lack of appropriate guidance for area classification outside of the energy and gas industries is a continuing barrier to the completion of good quality DSEAR assessments. The lack of understanding of the actual processes of area classification is somewhat unsurprising given the complexity of the task, and, in the author's opinion, Chemical Engineers are best equipped to carry out hazardous area classification.

Hazardous Area Classification guidance is at best patchy and at worst contradictory in several aspects. The issues regarding the assessment of ventilation in BS EN 60079-10-1 remain a significant concern, and no immediate resolution in in sight to this matter. The lack of hazardous area classification guidance in traditional process industries, in particular batch chemicals and pharmaceuticals is also of great concern as this industry sector has a large number of installations across the UK and globally. Specific guidance and a greater number of direct examples for the hazardous area classification of common process items such as batch process vessels, filters, pumps etc would be helpful.

The available guidance on release frequencies (Cox, Lees & Ang) is outdated and relies on information gathered in the 1960s and 70s and is becoming progressively less representative of modern chemical industry practice. Some information is also available in Lees "Loss Prevention in the Process Industries" although this is also somewhat dated.

Updated figures for the risk of leakage from flanges, pumps etc would be extremely useful but it seems unlikely that there is either the will or resources to gather and collate information even if it were available. In practice, the break-up of large companies such as ICI, Shell and BP into smaller business units, and the loss of traditional central engineering departments, means that there is a lack of new detailed information regarding loss of containment event data being generated and thus we are forced to rely in data which is, in many cases, over 50 years old and in all probability bears little relevance to modern plant designs or engineering standards.

There may also be some doubt around the use of the standard hole sizes used for area classification. The quoted small hole size of $2.5mm^2$ was originally believed to represent the loss of a segment of fibre gasket from a line. This size of hole is equivalent to 1.78mm diameter. Other sizes of hole are also listed in EI15 for various types of releases. These may benefit from updating and further consideration, potentially being somewhat large with the size of hole being dependent on the leak mechanism.

The number of consultants and contractors providing sub-standard DSEAR assessments for clients is worrying both from the safety aspect and also from a financial aspect. Part of the issue is undoubtedly the low level of knowledge within industry as to what an appropriate DSEAR assessment comprises. In many cases, these clients are below the level of "intelligent buyer" and thus are at the mercy of less scrupulous suppliers.

The research on flammable mist formation, whilst interesting, appears to bear little relevance to industrial practice and the results bear little relation to actual plant experience. This research needs to be evaluated with extreme caution. The area classification of fuel mists is likely to remain an issue for the foreseeable future. Given the low likelihood of mist explosions within the process industry, there must be a question about the cost / benefit of this research and the direct applicability to industrial situations.

Recommendations

Only Suitable Qualified and Experienced Personnel (SQEP) should be allowed to complete a DSEAR assessment. SQEP should include assessment formal qualifications in an appropriate subject e.g. Chemical Engineering, Chemistry or appropriate engineering discipline coupled with appropriate training and experience gained under supervision. A Chemical Engineering degree would be preferred but other degrees with appropriate training and mentoring are suitable. Chartered Engineer status should also be considered as an indicator of a minimum acceptable level of experience. Training should include the basics of flammability and explosion hazards, gas dispersion as well a risk assessment and hazardous area classification basics.

The lack of hazardous area classification guidance for the wider process and pharmaceutical industries remains a concern and specific guidance should be produced for this sector. This guidance should include a range of direct examples for the types of equipment and range of materials used in the process sector. In particular, the area classification batch process vessels, filtration equipment and filling of containers should be addressed. A range of common solvents should also be considered e.g. Toluene, Xylene, Acetone, Methanol etc..

DSEAR assessments should be reviewed periodically in order to ensure that they remain relevant. The review period depends to an extent on the complexity of the process and whether there are any changes to materials, equipment or operation. Needless to say, any changes to the legislation or guidance should also be taken into consideration.

It remains the responsibility of the end user to verify the competence of any personnel employed to carry out a DSEAR assessment. The paucity of end user knowledge and lack HSE resource in policing DSEAR compliance is an ongoing concern.

Comments

Whilst a formal DSEAR qualification for hazardous area classification and DSEAR risk assessment might be useful, it is difficult to see how this would be assessed and administered without excessive cost and bureaucracy and indeed who would be responsible for overseeing the assessments. The range of industries affected by DSEAR is so wide as to make generalist qualifications problematic other than for persons with considerable knowledge and experience. Further consideration will be needed for this issue.

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