How do you carry out a DSEAR Risk Assessment? Experiences from two of ABB's DSEAR/ATEX Experts

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This paper discusses the requirement to carry out a DSEAR risk assessment and describes different methodologies for conducting these assessments. Typical outputs from assessments are presented, and the advantages and disadvantages of each method are discussed.

A key element in demonstrating compliance with the DSEAR Regulations 2002 [1] is to carry out a risk assessment on process operations. Employers are required to assess all potential risks to employees and others whose safety may be affected by the use or presence of a dangerous substance at the workplace.

The DSEAR ACOP [2] lists the aspects of the process which the DSEAR risk assessment should consider, and the type of information which should be recorded from the assessment. However, no details or examples are given of how to carry out this risk assessment, or in what format the HSE expects companies to present the results of the risk assessment.

The authors' experience has been that although many companies have completed a Hazardous Area Classification (HAC) and defined the extents of their hazardous areas, they do not have a DSEAR risk assessment for their process.

This paper discusses the methodology which ABB uses when carrying out DSEAR risk assessments, based on its hazard study process, which has been developed from the ICI 8 stage hazard study process. Further details are given on the process information and personnel required for the risk assessment meeting, and the competency required to lead a DSEAR risk assessment meeting.

The ABB DSEAR risk assessment experience is then compared with the authors' experiences of conducting these risk assessments for other companies using a different methodology. Examples of typical outputs from a DSEAR risk assessment using each methodology are presented. Differences in the way the results are recorded, and the time taken to complete the risk assessment are discussed.

Finally the advantages and disadvantages of the different methodologies are considered, and the requirement to keep the risk assessment up-to-date. This includes ensuring that the additional requirements introduced in the 2015 update to DSEAR have been assessed. These are the risks from substances corrosive to metal and compressed gases, and materials with a flash point of up to 60ºC.

Keywords: DSEAR, Risk Assessment, Hazardous Area Classification, Management of Change, Compliance, Review.

Introduction

The Dangerous Substances and Explosive Atmospheres Regulations (DSEAR) [1] are concerned with protection of people against risks from fire, explosion and similar events arising from dangerous substances used or present in the workplace. The regulations have been in force for more than 15 years, yet many operating companies are still unsure whether they are fully meeting the requirements for compliance.

A key requirement of DSEAR is the need for a risk assessment. This must provide evidence that the employer is aware of all the risks associated with the dangerous substances used on site, and has applied sufficient measures to eliminate the risks or reduce them as far as practicable. The assessment enables employers to demonstrate that they have followed a structured and thorough approach in considering the risks to employees and the control measures that are needed.

The Approved Code of Practice (ACOP) for DSEAR [2] does not specify exactly how this risk assessment should be conducted or recorded, but does provide useful guidance. Key points which the risk assessment should record are: the nature of the hazard; who might be harmed, and how; the measures that are currently in place to address the risk; any additional measures that could be taken; and actions arising from the assessment of the risk.

The HSE's extensive guidance on risk assessment can be followed in developing a process for carrying out DSEAR risk assessments. The DSEAR ACOP states that DSEAR risk assessments should not be carried out in isolation from those required under other legislation, such as the Management of Health and Safety at Work Regulations, and that other risk assessments conducted by operating companies, such as fire risk assessments, functional safety studies etc., may cover many of the requirements of DSEAR.

It is important to note that assessing the risks from handling dangerous substances is distinct from the requirement to identify places where explosive atmospheres may occur, i.e. hazardous area classification. There remains confusion from companies requesting an 'HAC update' after an HSE DSEAR intervention, when what the company needs is a DSEAR risk assessment.

This is also different from a 'DSEAR compliance assessment/audit' which some companies carry out to assess whether they are compliant with all the DSEAR regulations, including marking of containers and pipes, emergency arrangements and training.

It is worth noting that it is useful to carry out a DSEAR risk assessment and hazardous area classification in parallel, as many of the questions raised in the risk assessment help in identifying where explosive atmospheres may be present, and how often.

Developing a DSEAR Risk Assessment

A good starting point for a DSEAR risk assessment is to examine the existing process safety risk assessments that a site already has in place, as these may have addressed many of the requirements of DSEAR. Many operators of high hazard processes have a range of risk assessments in place (e.g. HAZOPs, HAZIDs) which will have considered the risks associated with dangerous substances, and DSEAR does not intend to re-invent the wheel. Provided that a recognised process safety risk assessment methodology has been followed, and the risk assessment satisfactorily addresses the requirements of DSEAR, then it can be incorporated into a DSEAR risk assessment.

However, it is important to remember that DSEAR is concerned with the protection of people. The authors' experience is that while HAZOPs, HAZIDs etc. are good at identifying major accident hazards and their consequences, they can be less good at identifying risks to people carrying out manual operations, such as manual charging of materials to vessels or manual cleaning of equipment using a flammable solvent. Such manual operations are still responsible for personnel injuries and fatalities in the 21st century.

For example, a hazard study may have identified the potential for a major incident resulting in an internal explosion in a process vessel handling flammable materials, with major consequences and many safeguards in place as a result; but it may not have considered the risks associated with material handling. Charging powders into a vessel via the manway can present a risk to the operator carrying out the activity, either due to the flammable powder or if the vessel contents are flammable. The consequences can range from a flash fire to an explosion that kills the operator.

Nevertheless, reviewing a HAZOP or HAZID for scenarios resulting in a fire or explosion can be a useful starting point for a DSEAR risk assessment, especially if accompanied by a list of manual operations being carried out, including cleaning and maintenance operations.

Many companies have their own risk assessment procedures and formats, with risk matrices for categorising hazardous events. These can be used for ranking risks and targeting those that require further action to bring them into the tolerable if as low as reasonably practicable (ALARP) region. As with all risk assessments, the hierarchy of control should be followed: Eliminate; Reduce; Control; and finally, Mitigate.

DSEAR Risk Assessment Methodologies

The DSEAR ACOP does not detail how to carry out a DSEAR risk assessment so there may be many different methods used, and different ways of presenting the results. This paper discusses the method used by ABB, and compares it with the authors' experiences of using an alternative methodology.

Whichever methodology is used, the correct information on the process and suitably knowledgeable personnel should be assembled to carry out the risk assessment.

Information and Personnel Required

The risk assessment meeting requires information on the process being assessed and experienced personnel. Drawings (P&IDs or PFDs), information on the materials being handled and relevant process data, e.g. temperatures, pressures, flowrates etc. are needed.

Also, the risk assessment team needs to be suitably experienced including people with knowledge of the system being assessed, e.g. a process or mechanical engineer, and people with knowledge of how the system operates, i.e. knowledge of the operating procedures and job methods, e.g. operations manager or supervisor.

The person leading the risk assessment team should be suitably competent. They should be able to demonstrate extensive knowledge of the DSEAR regulations, and an ability to facilitate risk assessment meetings, helping the team to identify potential hazardous events, and guiding them through the development and assessment of these events.

The authors' experience is that it is beneficial to carry out the DSEAR Risk Assessment and Hazardous Area Classification exercise in parallel, where possible. This is because many of the questions about how, and under what conditions, a dangerous substance is handled in order to determine the location and extent of any explosive atmospheres (i.e. the Hazardous Area Classification), are the same questions which would be asked in the DSEAR Risk Assessment. Therefore, carrying out these two exercises in parallel can streamline the process, with the potential for savings due to increased efficiency.

Suggested DSEAR Risk Assessment Methodology

The methodology which ABB uses for carrying out DSEAR risk assessments is based on its hazard study process, which has been developed from the ICI 8 stage hazard study process.

This approach uses a guide word, top down method to identify hazardous events, to assess their severity and then to identify what protections must be in place either to mitigate the consequence or reduce the frequency of the hazardous event. The assessment takes into account the DSEAR ACOP guidance that a DSEAR Risk Assessment should not be carried out in isolation from other risk assessment activities; where appropriate it should be linked to other health and safety records or documents describing procedures and safeguards. In particular reference should be made to the site Hazardous Area Classification, which identifies the locations and extents of the explosive atmospheres caused by the dangerous substances.

The DSEAR risk assessment is carried out by dividing the process under consideration into a number of different areas/systems/nodes. Guidewords which describe event outcomes, such as fire, explosion or extreme temperature etc. are applied to each area to identify if or how these outcomes could arise (both the initial consequence and the ultimate consequence). Also, the protective measures currently in place to prevent the fire/explosion from occurring, or controlling or mitigating the consequences are recorded.

The risk assessment team ranks the event likelihood and consequence to determine the risk of the hazardous event, and then assesses it against the risk matrix being used to understand whether the risk is categorised as Low, Medium or High risk. Depending on where the event lies on the risk matrix, recommendations may be made to implement measures which will reduce the risk of the event, preferably to Low or Medium (tolerable if ALARP).

An example output from a DSEAR risk assessment using the suggested methodology is shown in Table 1 below.

Table 1: Example output from a DSEAR risk assessment using the suggested methodology

Activity / Hazard Event	Description	Severity	Likelihood	Risk Rank	Measures			Recommendation/ Actions
					Inherent/ Preventive	Control	Mitigation	
Hydrogen evolved during the reduction reaction is ignited by static generated by the addition of powder through open manway	Flammable gas ignited by static discharge	4 – Extremely serious (Flash fire, injury/ potential fatality to operator; fire may spread to engulf building)	A – Frequent (has occurred in the lifetime of the plant)	Very High			Site emergency response procedures	1. Perform additions in solution rather than in powder form. 2. Exercise control over static electricity – earthing of containers, anti-static PPE.

Alternative DSEAR Risk Assessment Methodologies

The authors also have experience of conducting DSEAR risk assessments for other companies using a different methodology. This method entails listing all the individual steps involved in a process and assessing each one in turn. First, describing the process step and where an explosive atmosphere may be formed. Then listing all the ignition sources which could be present and the consequence if ignition were to occur. Also, categorising the consequence and probability of the event occurring to establish the raw (unmitigated) risk.

Then listing the existing protection and prevention measures in place to protect against the consequence occurring. Next categorising the consequence and probability of the event occurring with these measures in place to determine the residual risk. Finally comparing the residual risk against the risk matrix to understand whether the risk is categorised as Low, Medium or High risk.

Depending on where the event lies on the risk matrix, recommendations may be made to implement measures which will reduce the risk of the event, preferably to Low or Medium (tolerable if ALARP).

An example output from a DSEAR risk assessment using the alternative methodology is shown in Table 2 below.

Table 2: Example output from a DSEAR risk assessment using the alternative methodology

Operation	Identified Risk	Potential Ignition source	Consequence	C	P	Raw Risk	Prevention & Protection Measures	C	P	Residual Risk	Recommendations
Bulk filling of vessels. Either via flexibles from flowmeter to top of tank elbow/dip pipe, or via permanent pipework. Solvent usually introduced to water already in tank, however for product X the solvent is introduced into an empty vessel.	Flammable vapours inside and around the top of the vessel.	Local non Ex electrics, hot surfaces, personal ignition sources, smoking materials, friction sparking, Static. Non conductive hoses.	Fire with potential for escalation. Explosion	5	3	15	All vessels where solvent is 'processed' have permanent extraction. Extract not interlocked to vessel filling operation.	5	3	15	Use Conductive hoses for solvent transfers. Check Earthing. Restrict personal ignition sources. Use Ex equipment including Ex radios in 'zoned' areas.

Advantages and Disadvantages of the DSEAR Risk Assessment Methodologies

The suggested method for DSEAR risk assessments is guideword-led, and the authors have found this to be an efficient process which focusses on the operations which have the potential to result in a fire or explosion. Other operations which may involve handling of flammable substances but where there is insufficient material present to form an explosive atmosphere, or where there are no credible ignition sources present, are identified, and the reason why there is no credible risk from a fire or explosion is recorded. However, the focus remains on the higher risk operations, and on formulating recommendations to reduce these risks. Consequently, the authors have found that, with the correct process and material information available, and a sufficiently experienced team, a DSEAR risk assessment can be efficiently completed for even quite a complex process in one – two days. Similar processes involving similar materials can be assessed together.

A possible disadvantage of this guideword-led method is that its success relies on having a sufficiently experienced study leader to facilitate the process, suggesting possible causes or hazardous consequences of the operations being carried out. If the risk assessment leader is not very experienced they may overlook a risk or underestimate the potential consequences. However, the authors, who have extensive experience leading DSEAR risk assessments and verify each others work, have not found this to be a concern.

The alternative DSEAR risk assessment method discussed above lists all the individual steps involved in a process, assessing each one in turn. Although ensuring that every process step is listed and assessed could be viewed as being commendably thorough, it can result in excessive time being spent on considering process steps where there is no credible risk. Consequently the authors have found that the focus on the higher risk activities can be lost among the myriad process steps being assessed. Another disadvantage of this method is that a DSEAR risk assessment can take considerable time (several days) even for a straightforward process. This can lead to the assessment team becoming tired, less efficient and the quality of the assessment, including the identification of risks, deteriorating.

Other requirements for DSEAR risk assessments

A key requirement of DSEAR is to ensure that documentation demonstrating compliance is kept up-to-date. DSEAR regards the risk assessment of a process as an integral part of the risk assessment documentation, and dictates that the DSEAR documentation must be reviewed at regular intervals. The frequency of review is not defined in the regulations, but it is advised that it should depend on the nature of the risk, and the likely degree of change. Therefore it follows that for a high hazard process, or one that is frequently reconfigured, a shorter interval between reviews would be appropriate.

Also, the DSEAR documentation should be reviewed whenever significant changes occur. It is therefore important for a company to ensure that its Management of Change (MoC) process includes prompts to identify whether the proposed change affects the risks associated with dangerous substances, and if so, that the DSEAR risk assessment and Area Classification are reviewed accordingly. It may be necessary to review the MoC process and the competencies of those authorised to handle such reviews, in order to ensure this requirement can be demonstrably fulfilled.

The ACoP also states that the DSEAR risk assessment should be reviewed whenever there is reason to suspect it may be invalid. This may be the case if a site has an incident involving dangerous substances. Even a near miss should prompt a review to ensure that the risks were correctly identified, with nothing overlooked, and consider whether additional safeguards need to be introduced.

The review also needs to ensure that the additional requirements introduced in the 2015 update to DSEAR have been assessed. These additional requirements are the need to assess the risks from substances corrosive to metal and compressed gases, and materials with a flash point of up to 60^{o}C.

Since there is no defined frequency for the regularity of reviews, it is important to define an interval that is frequent enough to demonstrate a commitment to maintaining compliance with the regulations. Good practice would be to identify an interval that is manageable for the process without being so frequent that adhering to the programme is impractical, or that the review becomes rushed and ineffective; whilst also ensuring that it is not infrequent.

Considering the frequency at which other process safety documentation is required to be reviewed can help to influence the definition of a suitable interval. Regulation 10 of COMAH [3] requires that safety reports are fully reviewed every 5 years; Regulation 23 of the Offshore Installations (Safety Case) Regulations [4] also requires a 5 yearly thorough review of offshore safety cases. The British Standard ‘60079 Explosive atmospheres Part 14: Electrical installations inspection and maintenance’ [5] specifies that fixed equipment inspection intervals should not exceed three years without the basis for the extension being documented.

Therefore an interval of three years can be seen as good practice and consistent with the requirements of other relevant standards. If there is sufficient evidence to justify a longer interval between reviews, then an interval of no more than 5 years would be advisable based on typical requirements for major accident hazard documentation.

Conclusions

In conclusion, compliance with the regulations requires a DSEAR risk assessment to be carried out, including materials with a flash point of up to 60^{o}C, compressed gases and substances corrosive to metal, and all DSEAR documentation to be regularly reviewed and updated.

The regulations do not specify how a DSEAR risk assessment should be carried out or recorded, or the required interval between reviews. This paper presents different methods of carrying out a DSEAR risk assessment, and discusses the advantages and disadvantages of each method. It also suggests an interval between reviews of 3 – 5 years is reasonable to enable compliance to be demonstrated and maintained.

ABBREVIATIONS

ACOP	Approved Code of Practice
ALARP	As Low As Reasonably Practical
DSEAR	Dangerous Substances and Explosive Atmospheres Regulations
HAC	Hazardous Area Classification
HAZID	Hazard Identification
HAZOP	Hazard and Operability Study
HSE	(UK) Health and Safety Executive
MoC	Management of Change
PFD	Process Flow Diagram
P&ID	Piping and Instrumentation Diagram

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