THE ROLE OF AN INNOVATIVE APPROACH TO DSEAR IN ACCELERATED EARLY CAREER DEVELOPMENT

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Under UK law, all water companies are required to ensure compliance with DSEAR regulations. To comply with this legislation, Scottish Water commissioned a joint venture of which Atkins was a main partner to update DSEAR assessments for over 1500 assets. This paper provides an overview of the innovative approach to DSEAR that is adopted by the framework consultants to ensure successful completion of these assessments in a shorter timeframe with a more efficient process. This paper also demonstrates how this collaborative effort provided a highly effective learning opportunity for all the people involved in the project.

KEYWORDS*: DSEAR, Dangerous Substance, Hazardous Area, Innovation, Learning*

BACKGROUND

The Dangerous Substances and Explosive Atmosphere Regulations (DSEAR) were introduced in December 2002. DSEAR implements the Explosive Atmospheres (ATEX 137 99/92/EC) Directive and safety requirements outlined by Chemical Agents Directive (CAD 98/24/EC) ("DSEAR in detail - Fire and explosion", n.d.). CAD 98/24/EC provides regulation on the "protection of the health and safety of workers from the risks related to chemical agents at work and the ATEX 137 99/92 EC ("Directive 98/24/EC - risks related to chemical agents at work", n.d.). DSEAR regulations are required to protect people from the danger of explosions, fires and energy releasing chemical reactions from the presence of a dangerous substance that may be potentially stored/handled or found in a workplace. Dangerous substances are defined by the HSE as 'any substances used or present at work that could, if not properly controlled, cause harm to people as a result of a fire or explosion or corrosion of metal' ("DSEAR in detail - Fire and explosion", n.d.). Some examples of these dangerous substances include ammonia gas, petrol, LPG, most common organic solvents, any kind of dust which when spread to air can cause an explosive atmosphere etc.

It is important to note here that although a few of these dangerous substances are known to cause health risks, these risks are covered under a separate law which is known as the Control of Substances Hazardous to Health (COSHH) and are not covered as such under DSEAR. COSHH is about occupational harm to people whilst DSEAR is a process safety dealing with harmful and significant loss of containment.

Employers are required to classify areas which are likely to produce a release of dangerous substances and cause an explosive atmosphere into hazardous and non-hazardous zones. Non-hazardous areas are places where an explosive atmosphere is unlikely to happen. A hazardous zone is a classification of a hazardous area based upon the frequency of the occurrence of the explosive atmosphere. There are 3 main hazardous zones which are Zone 0 where explosive atmosphere is present for a long period, Zone 1 where an explosive atmosphere is likely to occur in normal operation and Zone 2 in which an explosive atmosphere is unlikely to occur in normal operation or when it occurs, it will only be present for a short period. Within hazardous areas, certain provisions must be ensured for any fixed equipment that is located in these areas to prevent them from being a source of ignition.

The ATEX Equipment Directive 94/9/EC provides regulations relating to equipment that should be used in explosive atmospheres. Mitigation measures along with guidance on selection of equipment in hazardous areas are explained in detail by the HSE and can be accessed via their website. ("DSEAR in detail - Fire and explosion", n.d.)

According to the HSE, DSEAR compliance requires companies to carry out the following activities:

1. Carrying out a risk assessment to identify dangerous substances.
2. Eliminate risks where possible and where not practically possible, provide control measures to reduce the release of dangerous substances.
3. Provide mitigation measures by eliminating ignition sources.
4. Put emergency procedures in place to protect people.

INTRODUCTION

Atkins has been appointed as a consultant on the Scottish Water DSEAR Compliance Programme which aims to assess and update the DSEAR assessments for existing water, wastewater, and sludge management assets.

A preliminary study conducted by the framework consultants has identified the scale of risk of Scottish Water assets and grouped these into different tranches throughout the length of the DSEAR Compliance programme. These tranches prioritise those assets that present greater potential risk to Scottish Water. The first tranche consisted of sludge treatment centres and wastewater treatment assets with the most risk. The subsequent tranches included the remaining wastewater treatment works with lower risk and water treatment works. The final tranches include sewage pumping stations, raw water pumping stations and Alternative Pumped Non-Return Valve systems (APNRVs) with the least risk. By following this approach, the framework consultants were able to identify the sites that presented higher risk and required further study thus narrowing down the number of full assessments required and avoiding repeated efforts on sites with lower risks. Since 2019, Atkins has successfully assessed over 700 assets.

The Atkins DSEAR team consists of engineers from different technical backgrounds. Chemical engineers provide knowledge and experience about the different processes within a treatment works whilst Civil engineers provide understanding of materials of construction. Electrical and mechanical engineers impart their expertise on the different equipment used at these areas within the treatment works. This collaborative nature of the project is imperative to identify the complete breadth of any foreseeable catastrophic risk present on a site. The members within the team are grouped into three main roles a) Data Analyst Team b) Checking Team c) Approval team. Early career starters which include the graduates, apprentices and the summer placement students form the Data Analyst (DA) team which is responsible for gathering data and assessing. Checkers which are the senior engineers proficient in water and wastewater treatment works and Approvers who are principal engineers with knowledge and experience in HAZOP are responsible for the verification of DSEAR assessments created by the DA and approval of the DSEAR documents.

Previously, DSEAR studies were carried out by assessing risks on site for every asset. This was time consuming and often challenging to carry out in remote areas. Additionally, this method did not make use of significant site data present within the existing Scottish Water Database. The next section outlines an improved and optimised process to carry out DSEAR assessments

OVERVIEW OF DSEAR PROGRAMME

Following the guidance and common practice for DSEAR assessment, the Scottish Water DSEAR programme starts by undertaking a risk assessment of the site and then conducting a hazardous area classification exercise of the process units present on the site. This is carried out using the template for an Explosion Protection Document (EPD) as required by Directive 99/92/EC ("Directive 1999/92/EC of the European Parliament and of the Council of 16 December 1999 on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres (15th individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC)", 2000). This EPD has been automated into an excel programme tool by Scottish Water which consists of separate automated tabs for carrying out preliminary risk assessments, detailed risk assessments and for classifying the hazardous zones.

The risk assessment stage is further divided into steps to ensure that all available data relating to the site is recorded and that there is no room for error.

As a first step, the data analyst compiles existing information of the asset from the Scottish Water Asset Database. The next step is to ascertain risks emanating from the catchment where the asset is located. A Geographic Information System (GIS) mapping tool is used to assist with this. A GIS map of Scotland which incorporates information from British Geological Survey (BGS) maps and Scottish Environment Protection Agency (SEPA) maps is used for this purpose which shows the different assets under Scottish Water, associated pipelines and other infrastructure within the water/wastewater database, the map includes information about soil characteristics. This tool helps to identify dangerous substances that may travel into the asset either via conduits leading into the treatment works or by migrating from within the soil. Some of the dangerous substances that are discerned from GIS include methane from peat rich soils or from high development risk areas and FLIDS (Flammable Liquids in Drainage Systems) risks from heavy industries or from petrol stations that may drain into the catchment. Through GIS, the distance from peat rich and coal mining areas and the asset can be measured which is then used to calculate the concentration of methane in the conduits or the surrounding soil using the EPD tool. Following an initial examination of this data, the DA enters the relevant information into the EPD preliminary tab to determine if the asset requires a further detailed assessment based on any risks that have been highlighted.

The next step is to set up a call with the Scottish Water Asset Planner (AP). Asset Planners oversee the different assets under Scottish Water and have a sound operational knowledge and understanding of risks and the performance of the asset that they are responsible for. This is a crucial step as the desktop study alone cannot fully capture all the details of a site and its related risks. The call also mitigates any risk of missing changes/modifications to the site that may not be reflected in the design documentation as it captures the practical knowledge of the AP. The conversation with the AP allows the DA to identify petrol/

flammable substance risks within the catchment, recent accidents that may affect the catchment drainage, existing septicity issues within the network, possible dust explosions from powdered polymers, unsafe storage of chemicals etc. APs also highlight ongoing issues with the site. Prior to the AP call, the EPD undergoes a preliminary verification by the checkers to ensure that the data has been captured accurately within the tool. The checkers provide their observations and feedback to the DA and highlight any areas that need to be emphasized during the asset planner call.

With this information gathered at the desktop stage, the detailed risk assessment is carried out. In the detailed assessment, hazardous zoning calculations are performed for those process units at the site where either a dangerous substance is stored, handled or produced during operation (eg septic tanks, sludge holding tanks, fuel tanks etc.). An investigation of dimensions and ventilation configuration of the process units that are required for these calculations is conducted and where available, details are obtained from drawings available in the Scottish Water Database. Where this information is not available, the DAs must make reasonable assumptions with the guidance of senior members of the team. These assumptions are often the deciding factor to whether the process unit is zoned or not and hence any assumption that is made needs to be accurately validated by the DA and verified by the checker and assessor. These calculations classify each unit into different hazardous zones. Sketches are produced within the EPD to indicate the extents of zoning and the location of these units on site. These sketches are used to help Scottish Water identify where dangerous atmospheres can be created in order to prepare measures to either eliminate these risks or reduce them so far as is reasonably practicable. An equipment tab is also created within the EPD to help the reader locate and replace equipment in zoned areas with equipment that comply with the requirements of the Equipment and Protective Systems intended for Use in Potentially Explosive Atmospheres Regulations 1996 (EPS)("A Guide to DSEAR in the University", n.d.)

After a final check of the EPD, the assessment is then progressed onto the approval stage where the assessors carry out a detailed review of the site and provide feedback to the DAs and checkers based on their analysis and observations. When all information and all risks have been accounted for within the EPD, the assessor will sign off the site. This site will then be revisited in 5 years to carry out a second DSEAR assessment to account for any updates or changes that have been made to the asset.

By adopting this structured approach of constant validation and rigorous checking, DSEAR risks are identified, errors within the calculation are minimised and a strong feedback loop is created for the junior engineers to start learning about processes, equipment used and good practices within the water industry. This results in a robust and optimised process for completing the DSEAR assessments within the limited timeframe and ensures smooth and successful implementation of the project.

Figure 1 illustrates the various stages within the DSEAR assessment.

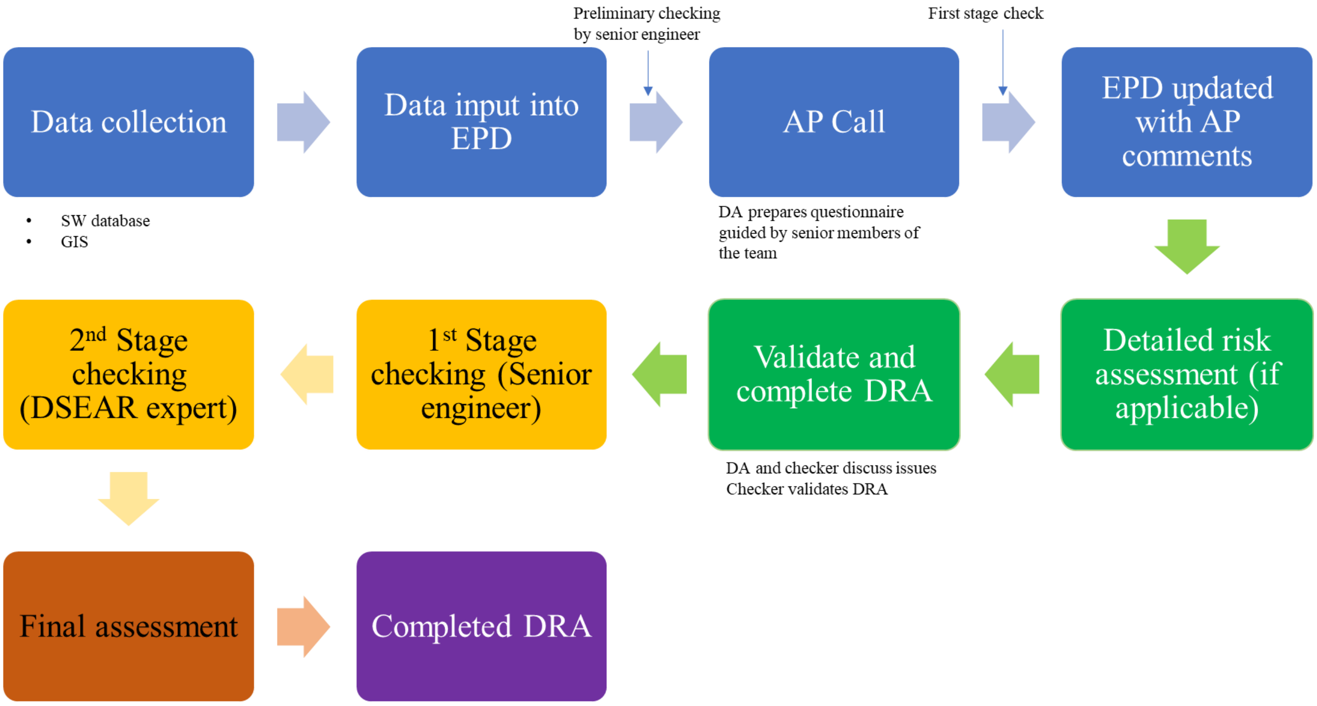

Figure *1* DSEAR Process Flow Diagram

LEARNING INVOLVED WITHIN THIS INNOVATIVE APPROACH

The DSEAR Compliance Programme within Atkins has provided continuous learning and intensive professional development for the graduates and apprentices within the team. Dividing the compliance programme into multiple stages not only optimises the entire process but also aims to improve the process knowledge of the DAs so that any risks to the site/asset can be highlighted earlier on in the programme. The constant feedback loop between the checkers and assessors during the preliminary stage helps the DAs to identify and understand the type and severity of the catchment risks/ process risks beforehand from the existing information. This feedback helps the DAs to gain familiarity with the plant processes significantly faster than would be naturally obtained through only working in their own discipline.

As mentioned above, the AP call is a pivotal stage within the DSEAR process and within the learning journey of the DA. Conversations with the checkers and assessors prior to the AP call steer the DAs to identify risks whilst conversing with the AP and to ask them relevant follow up questions.

Finally, comments from the assessors on the EPD provides an indispensable learning opportunity for both the DAs and the checkers as the assessors are recognised industry experts for HAZOP and DSEAR assessments within Atkins.

Throughout the length of the DSEAR programme, multiple training sessions are held. As continuous engagement between the team members is key to the success of DSEAR assessments, weekly meetings are held both on a project team level and a DA level. These meetings also provide a room for the DAs to discuss methods and techniques used by their peers for assessment, thus ensuring efficient progress and consistent quality in delivery of the report. Assets with uncommon potentially dangerous environments are reviewed with the technical lead of the project and these often turn into learning sessions for the DAs.

One such example is that of wastewater treatment works in the Argyll and Bute region, which had a complicated interconnected Odour Control Unit system (OCU). The odour control unit was subdivided into three main sections; Two Catalytic Iron Filters (CIF) units vented the thickened sludge storage tank and the two DAB units. Treated air from the CIF along with the air extracted from the inlet screens, grit removal, imported sludge screen, works liquor pumping station and the Membrane Bioreactor Facility was vented by the biofilter. Air from the biofilter and the air from the ventilated building was vented to the Granular Activated Carbon Filter (GAC) filter. As this was an unusual arrangement, separate release rate calculations were carried out. Release rates for each of the nodes were calculated using the EPD. An excel calculation sheet to summate the OCU vent release rates was created. Figure 2 shows the release rate and concentration calculation for the ductwork

	Node 1					
Term	**Release 1**	**Release 2**	**Release 3**	**Release 4**	**Extraction totals**	**Example calc cell source**
Air flow m3/s	2.00000	0.00000	0.00000	0.00000	2.000000	Calculated
Air flow m3/h	7200				7200.000000	D197
Flammable gas release m3/s	9.016E-05				0.000090	D216:G216
Flammable gas release m3/h	0.32458	0.00000	0.00000	0.00000	0.324583	Calculated
Extract air volumetric conc (v/v %)	0.005%					Calculated
						Use in OCU vent calc
Combined concentation %					0.005%	Insert into D154
Total release volume m3/s					2.000090	Insert into D124
Total release m3/h					7200.324583	

Figure 2 Release rates for the OCU ductwork

After carefully reviewing the process operations with the technical lead and the assessors, the air extracted from the building ventilation and the subsequent combined air released from the GAC was determined to be non-hazardous. Hence, the OCU calculation was revised to include only the ductwork which vented the air from the various points of release as discussed above. Figure 3 below shows the breakdown of the odour control unit.

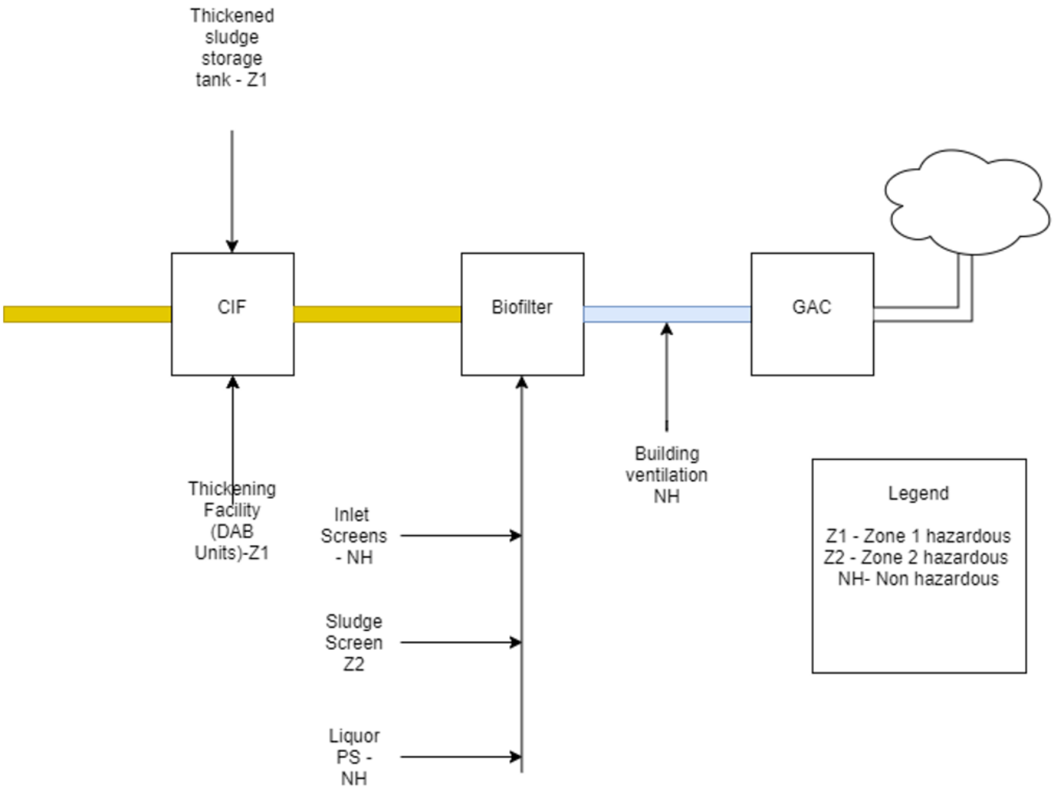

Figure 3 - OCU System observed at a WwTW in the Argyll and Bute Region

Another example of an uncommon configuration was observed at a pumping station in West Lothian (see Figure 4). This asset included vacuum pumps to generate negative pressure and draw sewage from the network into a vessel. Downstream of the vessel discharge pumps would pump sewage to the treatment works. This pumping station was located downstream of a septic tank with a different asset tag. This was a challenging assessment as the configuration of the site was very uncommon and the DSEAR assessment had to consider the risks migrating from the septic tank into the vacuum system. The DA was guided by the checkers and the technical lead to investigate the asset for any water traps or a vented chamber located in between the septic tank discharge and the pumping station to stop gas migration. GIS maps, existing drawings and documents from the database, and a call with the AP did not suggest the presence of these chambers, hence after a review, it was decided that the zoning classification from the septic tank was to be extended to the vacuum system. This was an important learning moment for both the DAs and the checkers within the team as this setup is not usually seen in typical pumping stations.

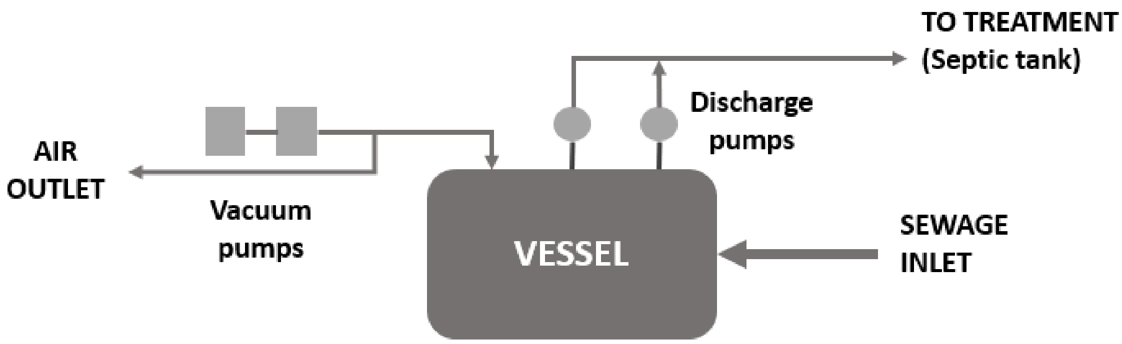

Figure 4 Unusual configuration of a pumping station observed in West Lothian

These examples demonstrate the importance of feedback sessions for the DAs. Through these, the DAs gain clear understanding of different dangerous environments within an asset, methods to appropriately categorise these areas and learn about the working of these process units without the need to be on site.

INNOVATIONS WITHIN THE APPROACH

As the programme progresses through its different tranches, integrating innovative technology within each step involved within the programme is essential for efficient data mining. An example of this is utilising GIS information to determine any conspicuous catchment risks earlier on in the programme. In the first tranche, information regarding the catchment which included petrol stations in the area likely to drain into the asset, peat rich area and landfill sites were gathered from different sources. This meant that the DA had to separately extract information from geology and coal authority BGS maps, SEPA data visualisation tools, etc. for each asset. One major drawback of this method was that it increased inconsistencies between the data extracted from numerous sources. Another shortcoming of this method was that considerable amount of time and resources were spent in the preliminary stages. In the second tranche, this limitation was eliminated by centralising the process. The asset data within GIS was modified to include all necessary catchment information within a single map. This modification has significantly reduced errors that were observed during the first tranche between the multiple maps.

The EPD template has undergone several upgrades to cover the different equipment within an asset and to include all the possible dangerous situations that may arise at these sites. At the close of every tranche, technical issues with the EPD are discussed and suggestions to optimise the EPD to create a user-friendly interface are taken onboard and upgrades are carried out. An example of the upgrade is the addition of generic calculation nodes within the EPD. The technical lead team from Atkins and the partner framework consultant collaboratively reviewed sites at the end of Tranche 2. Process units (eg. Septic tanks) that always fell under the same hazardous zoning in the DSEAR assessments were highlighted during this audit. The team investigated the conditions that lead to the formation of these hazardous areas and developed a pre-filled calculation node for these units. Over time, this library of generic node assessments has increased to include digestors, gas holders, boreholes within high development risk areas, fixed LPG facility etc.

These upgrades have not only optimised the DSEAR assessments but also reduced the timeframe to carry out assessments for each tranche which has resulted in significant savings for the client.

BENEFITS TO THE COMPANY AND CLIENT

The structured programme adopted by Atkins has proved to be beneficial to both Atkins and the Client alike. The DSEAR programme plays a pivotal role in the career development of the graduates and the apprentices involved. With the DSEAR programme, graduates are able to learn early on about the importance of process safety. In addition to gaining extensive knowledge on process operations and safety, graduates are also given an opportunity to acquire interpersonal and management skills. As the DSEAR team within Atkins is spread across UK with members from England, Scotland and Northern Ireland a few members from India, early career starters learn to adapt quickly in diverse environments and even through virtual platforms.

The DSEAR programme has also resulted in significant cost savings for the client. The efficiency of the desktop studies carried out by the team has decreased the need for site visits which otherwise would have been necessary to carry out an assessment if the traditional approach was followed. Most of Scottish Water's assets are often in remote areas and travelling to these assets to carry out DSEAR assets is impractical and time consuming. By carrying out these desktop studies and validating and approving the DSEAR assessments with the expertise and experience of the assessors along with the practical knowledge of the asset planners these visits are avoided which directly translate into reduction of unnecessary travel time, reduced risks to surveyors on site and a decrease in carbon footprint.

This is evident from Figure 4 which illustrates the assessments for sewage pumping stations and raw water pumping stations that Atkins has carried out as a part of the DSEAR compliance programme in the last 2 tranches (January 2021 to August 2021). From this chart, it is evident that majority of the assessments have come out as non-hazardous assessments. These assets do not require a site visit to verify equipment or validate assessments.

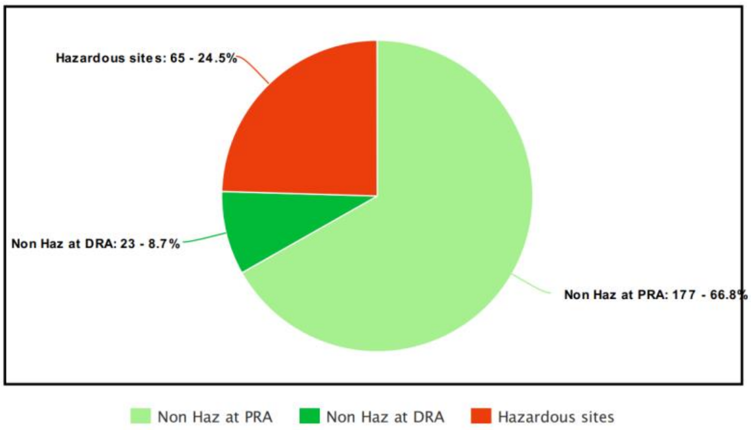

Figure 5 *Breakdown of assets assessed by Atkins from January 2021 to August 2021*

Hazardous sites require a site visit for verifying if the equipment on site is EX rated, assets fall under the appropriate category for their corresponding zones and are safe to be used in hazardous areas or to validate assumptions that have been made to complete the assessment. To assist with this, the equipment schedule, and the assumptions log within the EPD provide a clear guide of all the areas that need to be examined on site. These measures significantly reduce the time spent on site and aid the surveyors in carrying out safe site visits and focusing effort on areas where there is greater risk.

Another advantage to following this approach to DSEAR compared to the conventional format is that assets are under a periodic review. The DSEAR assessments carried out by Atkins are revisited in 5 years or prior to any construction change whichever comes earlier.

SUMMARY

This paper set out to provide an overview into the DSEAR Compliance approach that is followed by Atkins. This robust method of carrying out DSEAR studies yields much faster completed assessments when compared to the traditional approach to DSEAR. The continuous validation and feedback loop between the Data Analysts, the checkers, assessors, and the technical lead makes certain that all possible risks leading to explosive atmospheres are captured earlier on in the assessment. The DSEAR programme also supports the team member's learning to accelerate career development through training in wastewater and water treatment works and in innovative technology such as GIS. Additionally, the comprehensible format of the DSEAR documents aid the client to fully focus on areas that require preventative or control measures in place.

Through practical examples it has been shown how this approach has efficiently incorporated an interdisciplinary and holistic effort of engineering which provides invaluable opportunities for training of early careers professionals, significant savings for the client and reliable Explosion Protection Document that ensure safer operations.

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