

University of Wales Trinity Saint David

School of Engineering

Pollution Control Report

Environmental Pollution Control (ACMA 6006)

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Energy and Environmental Engineering (BEng)

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Contents

1	Introduction	3
2	Risk Assessment	4
3	Mitigation.....	9
3.1	Chemical Spillage.....	9
3.2	Hazardous and Toxic Substances and Byproducts	10
4	Compliance Strategy	12
4.1	Risk-Reward Trade-off.....	13
5	Conclusion	15
	References	16

1 Introduction

Preventing, reducing, and controlling pollution and impact of pollution that any one process, activity or activities cause is an essential measure in protecting populations, ecosystems, and wildlife. Successfully doing this requires the identification and targeting of key issues to enable more environmentally processes and practices to take place. A fundamental way of achieving this is by performing a risk assessment. Risk assessment is the process of identifying hazards and reducing the risk by implementing control measures that minimise the likelihood of a hazard causing harm and/or dampen the potential harm caused. There are generally acknowledged to be around 6 different variations of risk assessment, these being: vulnerability based, threat based, asset based, quantitative, qualitative, and semi-quantitative (Drata, 2024) (Risk Optics, 2023).

These risk assessment methods can be understood simply as:

Vulnerability Based: Identification of risks beyond the plant itself.

Threat Based: Identification of risks that come from the outside in.

Asset Based: Identification of risks to plant assets.

Qualitative: Identification of risk based on observation.

Quantitative and Semi-Quantitative: Identification of risk based on numerical data.

(Risk Optics, 2023)

To assess the pollution hazards and associated risk of an engineering plant, it was decided that a semi-quantitative site-specific risk assessment was the most appropriate.

The site is located in a residential and warehousing area in a small town, producing metal components involving grinding, machining, and welding operations, with these activities performed frequently within enclosed and sometimes in open booths. Chrome plating and galvanising operations are also present. There are over 50-tonnes of solvent being stored on site in chemical bunds.

This choice of method is due to its easily interpretable nature, categorising each hazard into a simple high, medium, or low risk rating. What is most helpful about this is that it creates a simple understanding of the areas which are the most detrimental and how the appropriate measures can reduce the scale of the risk. Further as it factors in the severity and risk in relation to each other, it provides a balanced basis for the scale of risk. This method is helpful in assessing the different ways mitigation procedures impact the risk score, for example, in some instances the severity may be decreased by mitigation but not the likelihood and vice versa.

2 Risk Assessment

RISK ASSESSMENT TITLE								
Operational Engineering Plant								
RISK ASSESSOR NAME	UNIVERSITY INSTITUTE / DEPARTMENT			BRIEF DESCRIPTION OF ACTIVITY				DATE VALID FROM
Nathan Skyrme	WISA - engineering and environmental management			Assessment of ongoing activity at a plant performing manufacturing, coating and spraying operations on metal.				06/02/2024
AUTHORISING LINE MANAGER	PERSONS AT RISK			DATE(S) / LOCATION(S) OF ACTIVITY				REVIEW DATE
Dan Wu	Employees, Local Residents and Workforce			06/02/2024 Off-Site				TBC
HAZARD	POTENTIAL HARM	RISK RATING			CONTROLS			RESIDUAL RISK
List what could cause harm from this activity.	For each hazard, identify the type of harm that could occur e.g. biological, physical, chemical, safety, ergonomic or psychosocial	See Risk Ratings Tab			For each hazard, list the measures you will be taking to minimise the risk identified.			See Risk Ratings Tab
		Severity	Likelihood	Risk				Severity Likelihood Risk
Storage Bund Degradation and Leakage	Increased risk to health and safety of employees and potentially surrounding local area and population, including wildlife. Leaching into ground, drains and atmosphere.	4	3	12	Ensure appropriate storage safety margin is available and bunds are not overfilled. Emergency response procedure in place to ensure any incidents are contained. Log kept of any previous incidents. Regular maintenance to check bund condition and log condition over time. Swift and appropriate response to any noted damage or potential weak points.			4 1 4

Emission of chemical particulate matter	Health risk to employees and local population, including wildlife. Respiratory damage and potential carcinogen.	2	2	4	Reduced use of open booths for chemical activities, especially high-risk activities such as spraying. Reduced use of chemicals where possible. Alternative or less harmful chemicals used where possible. Containment of chemical to designated areas. Appropriate ventilation and atmospheric treatment procedures.	2	1	2
Metal Swarf (Debris)	Health and physical risk to employees operating the machinery. Where operations are performed in open booths, there is a health risk to surrounding local area and population, including wildlife. Risk of leaching into watercourses.	2	2	4	Containment of activities leading to swarf, activities performed in only in enclosed booths. Regular cleaning of workshop and removal of swarf from clothes, ideally specific clothing should be used for these activities and cleaned between use. Appropriate PPE worn by operator.	2	1	2
Chemical Release into Ground and Water Systems	Health risk to local population through consumption. Ecosystem degradation. Damage to wildlife.	2	3	6	Containment and monitoring of chemicals and use. Log of incidents and report to the appropriate authorities/bodies of any accidental release.	2	2	4

Hazardous and Toxic Byproducts	The production processes produce gases, sludges and toxic heavy metals. Metal grinding and machining cause metal dust; machining also produces byproducts such as oil contaminated water. Harmful if not contained. Risk of harm to population, workers, environment and wildlife.	4	5	20	Containment and monitoring of byproducts created. Development of a suitable process for the containment and removal of waste byproducts. Appropriate PPE worn by staff in risk of contact.	4	2	8
Exposure to harmful substances	Employees can develop severe health defects as a result of working with harmful substances. E.g. Chromium is highly carcinogenic, metal swarf causes respiratory issues, etc. Effects can be worsened by working in enclosed booths.	5	4	20	Correct PPE available, and procedures with training in place, e.g. use of appropriate masks during spray and chrome plating operations. Emergency response procedure in place for all accidents. Hazard exposure first aid training for employees with appropriate first aid kit and stations, e.g. eye wash station.	5	2	10

Chemical Spillage	Hazard to employees in the affected area. Risk of leach into local ecological area; further risk of harm to wildlife.	5	3	15	Development of suitable procedures to contain and clear any spills. Active monitoring and maintenance of all chemical storage and its condition. Appropriate PPE available and worn by employees with suitable training. Safe and secure storage of all chemicals not in use.	5	2	10
Air Emissions Release	Various substances including but not limited to, fumes, dust, oil mist, noxious gases (e.g. Co2), releasing into the atmosphere due to the metallurgical processes used in production.	3	3	9	Control and containment of emissions. Long-term emission reduction targets. Processes causing release contained to closed booths. Suitable ventilation. Use of portable air-cleaner to remove particulate in the immediate area.	3	2	6
Noise	Various loud noises produced from the metallurgical processes, disruptive to both those in and around the plant.	1	3	3	Dampening to booths and factory walls. Operations, especially the loudest, kept to reasonable hours, i.e. 7am - 11pm. Noisy operations kept within closed booths.	1	2	2
Incorrect Disposal of Waste	Disposal of byproduct, waste material, etc. Risk of contamination to local ecosystem and harm to wildlife if disposed incorrectly.	4	3	12	Refer to local authorities for disposal options and best practices; where appropriate, use specialised contractors. Create and keep record of waste and the way it was disposed. Ensure waste is contained prior to disposal.	4	1	4
Waste Water Discharge	Waste product, byproduct, chemicals or other harmful and/or toxic substance discharging through the foul and/or surface water drains. Harmful to local ecosystem and wildlife. May also effect population by leaching into drinking water.	4	3	12	Ensure that all potential contaminants are appropriately contained. Regularly maintain any containers and monitor their condition. Refer to local authorities for the most appropriate disposal options; use specialised contractors where appropriate. Use of filtration system to separate suspended solids from waste water; appropriate storage of and disposal of both substances is essential.	4	1	4

References used in Risk Assessment: (Ottanik, et al., 2024) (APT, 2024) (Pilat M et al., 2006) (Strickland P et al., 2014) (Arita A et al., 2011) (Liu S et al., 2022) (Galvanizers Association, 2024) (Bruynzeel, 2022) (NetRegs, 2024) (Haider J et al., 2014) (Safety Storage Systems, 2024) (State of California, 2018) (Filson Filter, 2020)

3 Mitigation

Of the 11 hazards identified through the risk assessment, 3 of these are considered to have a high-risk categorisation. These being: Chemical Spillage, Hazardous and Toxic Byproducts and Exposure to Harmful Substances. In order to address these issues effectively mitigation procedures and requirements will be outlined within this section. These will include but are not limited to legislative requirements and pollution control equipment.

3.1 Chemical Spillage

A chemical spillage can cause serious injury to individuals in the local vicinity where the spill happened. If a chemical spill were to happen beyond the regulated region within the plant, it would impact the nearby ecosystem, population, and wildlife. During a spill, it is crucial to implement many key procedures to control and reduce its impact.

One of the first and most vital elements of spill control is to confine the spill as much as possible to the area where it has been spilled and prevent spread as much as possible (The Regents of the University of California, 2024), in the plant context, it is crucial to ensure that any object(s) which have become contaminated by any chemical do not leave the area, these may include surrounding equipment or clothing, such as shoes. Confining the spill should start with shutting down the area and evacuating those within the room in which the spill has occurred (Stony Brook University, 2024). First aid should then be administered by trained employees to anyone who has come into contact with the chemical. The incident including any injuries must be logged in an accident book in accordance with the Social Security (Claims and Payments) Regulations 1979 and Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013 (RIDDOR) (HSE, 2018) (Safety First Aid Group, 2024) (HSE, 2013). Once the spill area has been isolated, appropriately trained employees wearing suitable Personal Protective Equipment (PPE) (New Pig, 2022) should using a spill kit begin adding absorbent pads to the spill (Storemasta, 2023). When the spill has been sufficiently removed from the contaminated surface, the surface(s) affected should be decontaminated by the removal of any remaining chemical traces, and disposal of any waste, including contaminated PPE (ACS, 1995). Further the room should be ventilated in order to allow any airborne chemical remnant to dissipate (ACS, 1995).

If an incident occurs in which chemicals contaminated an area outside of the plant, this must be reported to Natural Resources Wales as an environmental incident as per the Environmental Damage (Prevention and Remediation) Regulations 2015 (Natural Resources Wales, 2024) (Adler and Allan, 2020).

In some cases, such as a large spill, it may be considered appropriate to contact the emergency services via 999.

Providing in-depth training on handling and working with the chemicals being used in operations present on site will increase understanding and reduced the likelihood of an incident occurring. All employees working in plant areas where any chemicals are present, should be fully trained and made aware of the dangers present, regardless of whether they are directly working with the chemicals or not.

To prevent an incident occurring to begin with, all chemicals should be appropriately stored, and the condition of storage should be regularly checked and maintained with records kept, in order to

ensure that chemicals are not being stored in ways which may compromise safety and increase risk. Any discovered instances of improperly stored chemicals should be immediately addressed.

3.2 Hazardous and Toxic Substances and Byproducts

Hazardous and toxic byproducts are materials and substances created by the processes employed during manufacture (Cambridge University, 2024). While not all byproducts are dangerous or toxic, those that are can lead to significant issues, affecting both production processes and the environment, as well as individuals in close proximity.

Mitigation methods employed can often effectively target multiple areas. To prevent exposure to harmful substances, similar precautions should be taken as to the handling of byproducts. Ensuring that both employees and those outside of the plant are not exposed to harmful substances will require a rigid control and monitoring of health and safety practices within the plant.

Some of the hazardous byproducts created by the plant processes include, gases, sludges, dust, contaminated water, toxic metals, etc (Bruynzeel, 2022) (NetRegs, 2024) (Haider, et al., 2014).

The first line of contact from the substances is to the employees working with the operations that produce them. To decrease the risk of harm to them, appropriate PPE and health and safety training must be provided as per, Work Regulations 1992 (RS, 2023) (HSE, 2024). The PPE needed will be contextual to the operation performed, for example for the grinding process the recommended PPE will be safety goggles, respiratory mask, gloves, aprons and steel-toe boots (CCOHS, 2023). Further, it will be important for certain operations which create airborne byproducts, such as dust or gases, etc. to have an appropriate ventilation system to remove these from the working area (HSE, 2024).

Anyone within proximity of harmful substances, should be required to wear full PPE, even if they are not handling the substance themselves. If anyone person(s) is exposed to harmful substances, there should be clear methods to reduce the risk of harm immediately, equipment such as eye wash stations, safety showers, etc. should be used to best provide a quick point of remediation, and are a legal requirement in workplaces where employees may come into contact with harmful substances under The Health and Safety Regulations act 1981 (DDS, 2018). The plant is also required under The Health and Safety (First-Aid) Regulations 1981, to have an appointed first aider, who if needed must attend to any affected parties (HSE, 2024). All employees handling or working proximity to harmful substances should be fully trained and aware of the correct emergency response procedures in case of an accident.

Any incidents which occur should be noted in the plant's Accident Book as required by the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013 (West Lindsey District Council, 2024). Further the PPE used is not just an effective measure against short-term injuries, but also against long term damages that may develop, e.g. respiratory illness from the long-term inhalation of swarf, or gases, etc. If exposure is serious then the emergency services must be contacted immediately via 999 by a third party.

Primarily reducing the harm these byproducts cause and the hazard they present will lie in the proper handling and disposal of them. These byproducts if introduced into the environment can cause significant damage to the ecosystem and wildlife, as well as to the human population through either contact or contamination, i.e. consumption of contaminated drinking water.

Preventing an incident relating to these byproducts, will first and foremost require an understanding of the substances that are being produced. With this a more effective understanding of the harms

and risks that can occur can be established, and therefore more suitable remediation measures deployed. The approximate amount of byproduct created from processes should be noted and suitable disposal methods arranged. Hazardous waste should be separately stored from general waste prior to disposal (Business Waste, 2024). A registered or exempt carrier must be the sole disposal agent used to remove all waste (Natural Resources Wales, 2023) and must be done so in accordance with The Hazardous Waste (Wales) Regulations 2005 (HM Government, 2005).

In the case of the plant introducing harmful substances to any external areas, it will be required to immediately report this to Natural Resources Wales as an environmental incident as per the Environmental Damage (Prevention and Remediation) Regulations 2015 (Natural Resources Wales, 2024) (Adler and Allan, 2020). This will most likely result in a fine. To prevent this occurring the use and storage of all harmful and hazardous substances should be closely monitored. Further they should be correctly stored, and the condition of storage should be regularly monitored and maintained.

4 Compliance Strategy

Owing to the plant's history of environmental incidents, there can be known to very clear problems occurring within its operation. While accepting the occasional fine may not seem like much, it is indicative there are serious failings within the plant and that a major incident may be about to unfold given this neglect. The focus of the strategy proposed here, will be chemical spills.

The term 'chemical spill' can be considered fairly relative, as this could mean anything from a few drops to several litres. The range between which this event can occur should cause serious concern and bring major consideration to the practices of the plant. A spill could affect employees and local residents causing injuries as minor as a burn or as major as death (NHS, 2020). Further if the spill is not contained within the plant, it can cause huge deterioration to the surrounding ecosystem and wildlife, leading to the destruction of habitat, contamination of resources and wildlife death (NOAA, 2022).

Given the wide range of potential damage, it is a huge gamble to continue to accept the occasional fine and not reconsider the practices in place to prevent and minimise the likelihood of an incident occurring. It is also worth noting that under the Control of Major Accidents & Hazards Regulations (COMAH) the plant is legally required to implement measures to prevent any incidents involving hazardous substances (First Mats, 2023).

A very simple initial method to implement will be to regularly check the condition of the chemical storage bunds containing the spray and degreasing solvent. The condition should be inspected regularly, around once every 1 to 2 weeks, and must as per the Water Pollution Act 1977, 1990, pass a bund integrity test once every 3 years (Safety Storage Systems, 2024) (Darcy, 2024). The bund should be checked regularly, for visible damage, leaks, cracks and air leaks (First Mats, 2023). These tests can be performed by the regular plant maintenance operative, so presuming there is currently one present, there is no additional cost. Although it is recommended that they receive suitable training from a qualified technician, which will likely carry a small cost (Adler and Allan, 2024). The bund integrity test and any serious maintenance can be performed by specialised contractors at a cost of approximately £2,000 - £4,000 for maintenance (Strandek, 2019)

In the instance of a small spill, it will be crucial to contain this as soon as possible to prevent spread. A simple way to do this as discussed in section 3.1 will be with the use of a spill kit. These come at a cost of around £125 per 120-litre capacity for the base unit (Roadware, 2024) (Hermeq, 2024) with spill kit refills costing roughly £60 per 120-litre capacity (Spillshop, 2024) (Empteezy, 2024). In order to safely remove the spill PPE will also be required in the form of a lab coat, goggles, gloves and protective clothing (Stony Brook University, 2024), all combined for a single set the approximate cost would be around £38.03 (Arco, 2024) (Workwear Express, 2024) (Health and Care Ltd., 2024) (Seton, 2024). This PPE can be reused so it may be that only a few sets are needed. Additionally, the recommended PPE should already be available in the plant as standard, therefore assuming so, there may be no additional cost.

In case of human exposure to any chemical, eye wash stations and safety showers will need to be available as per The Health and Safety Regulations act 1981 (DDS, 2018). To install these units the cost will be around £312 for a wall mounted eye wash station and £206 for a wall mounted safety shower (Safety Eyewash, 2024). A first aid kit should also be available, costing £35 (First Aid, 2024).

The methods recommended for implementation are fairly simple but can create a huge difference in the amount of risk the plant and local area is exposed to. By creating upholding routine procedures, potential risk can be noted and resolved, and severity of injury can be reduced significantly.

However, if these practices are not deployed, there can be enormous financial risk to the plant, as well as to the reputation of the plant which will lead to reduced sales and a lower ESG investability score. The two major sources of risk are to the environment and employees.

If a chemical spill occurs and leeches into areas outside of the plant, the first port of call will be with Natural Resources Wales who will then be responsible for responding to and issuing penalties for the spill (Natural Resources Wales, 2024). Previously Natural Resources Wales have imposed fines of over £200,000 for river pollution, which lead to the death of local wildlife (Wales Online, 2023) Even their more modest fines for these incidents have still been upwards of £40,000 (BBC, 2019) (Wales Online, 2023).

If the chemical spill were to harm the local population or employees, then there would be likely even larger financial consequences. The amount payable in the instance of harm to an employee or local resident is quite ambiguous and depends largely upon the injuries they receive. Although in many instances the eye wash station and safety shower should be able to significantly reduce the harm caused by any accidents to employees.

Recent changes to the Environmental Permitting (England and Wales) Regulations 2016, have removed the £250,000 limit on fines, and given Natural Resources Wales the power to issue fines without criminal proceedings and of an unlimited cost (Independent, 2023).

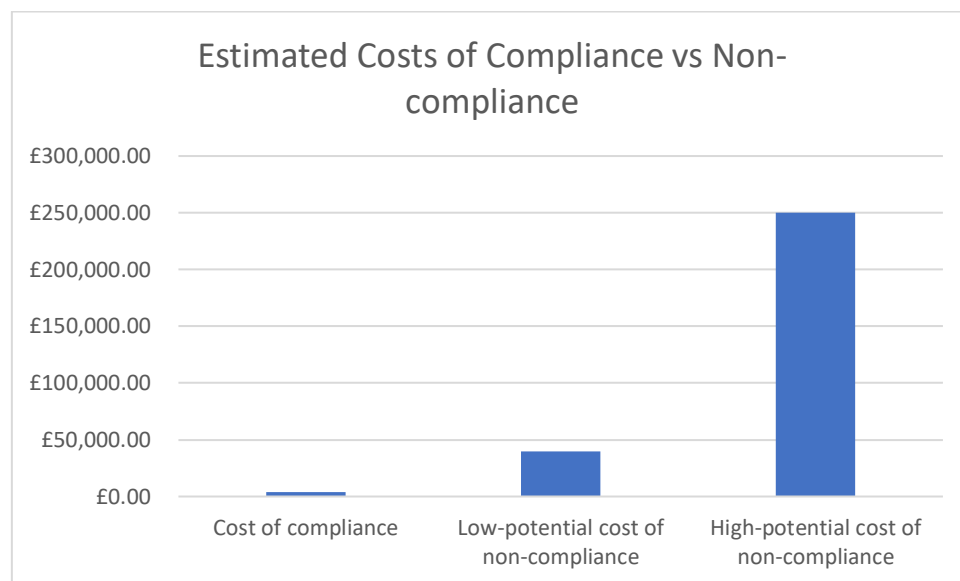


Figure 1 - Estimated Cost of Compliance vs Non-compliance.

4.1 Risk-Reward Trade-off

As stated at the beginning of this section, it is extremely important to reiterate the massive gamble that not taking these small procedures takes with not only the plants finances, but its operational future, the towns economy (as a major local employer), and even the lives of employees and local residents. While it may seem ok to continue to accept fines occasionally, these fines are indicative of organisation failings, to properly operate the plant. The cost of implementing the above-mentioned procedures and equipment is minute compared to the potential fines that may be received when the

inevitable large-scale accident occurs. It is firmly recommended that this course of action is taken immediately for the benefit and safety of both the plant, employees and town.

5 Conclusion

As fig.1. shows the potential cost of non-compliance is extremely high compared to the simple procedures that have been recommended for implementation. It is recommended that in order to control the likelihood of occurrence and reduce the severity of harm in the case of an incident occurring, that the appropriate health and safety equipment listed, (eye-wash station, safety shower, PPE, etc.), is purchased and made available in the plant in accordance with The Health and Safety Regulations act 1981. Regular checks and maintenance should be performed by appropriately trained staff, and all staff working the proximity of any chemical(s) should be fully trained on how to handle it, made aware of the dangers, and trained in the appropriate measures to take in the instance of an accident occurring. The recommended purchases can be made at an estimated cost of £3770, this is very cheap compared to the potential cost of a fine or even in the case the plant is sued for negligence. Therefore, it is recommended that these measures be implemented immediately.

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