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# Occupational Health, Safety, and Environmental Risk Management in the Oil and Gas Sector: Challenges, Precautions, and Implications

By

Faith Mmesomachukwu Kelechi\*

## Abstract

*There are risks related to Health, Safety, and the Environment (HSE) in businesses. These risks can be harmful to people and the environment. HSE experts help make things safer, especially in the oil and gas industry where there are dangers during activities like exploration, drilling, production etc. Workers can be exposed to dangerous gases, like hydrogen sulfide. To keep everyone safe, we need three important things: managing these gases well, planning carefully, and making sure employees are trained properly. Oil and gas industry workers can also get sick from exposure to chemicals, which can cause lungs, skin, and other organs problems. Noise at work can lead to loss of hearing. There are the risks of serious injuries and fatalities especially to inexperienced and poorly supervised workers. To make things safer, we need to find and understand these risks and figure out how to control and deal with them. This research is important because it helps us learn how to manage these risks better. It looks at the problems and solutions to make the workplace safer for workers and the environment. In the end, managing HSE risks in the oil and gas industry is crucial for a safe and sustainable energy sector. By carefully assessing, planning, and training, businesses can reduce risks and prevent accidents. This study shows us the challenges and steps needed to manage these risks safely, stressing the importance of following safety rules. The paper emphasizes that by putting worker safety and health first, the industry can move towards a safer and more responsible future.*

**Keywords:** Health Safety and Environment (HSE), Risk management, Hydrogen sulfide, Drilling, Safety monitoring

## Introduction

The increasing focus on Health, Safety, and Environmental Risk Management (HSE) in various industries, including the oil and gas sector, has become a significant concern for stakeholders such as workers, governments, and communities<sup>1</sup>. However, the complexities involved in HSE management, and the associated costs have made it challenging for industries to address these concerns. The need for world-class performance and operational excellence has become more critical in recent years, particularly after incidents such as the Deepwater Horizon oil spill in the Gulf of Mexico. Effective management and engineering practices, as well as the constant improvement of knowledge and efficiency, are necessary to prevent dangerous shortcomings and safeguard environmental health.<sup>2</sup> The impact of such misfortunes on the environment, finances, health, and social aspects of the industry and its stakeholders cannot be overemphasized. It

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<sup>1</sup> Benjamin Edokpolo, Qiming Jimmy Yu and Des Connell, 2015, "Health Risk Assessment for Exposure to Benzene in Petroleum Refinery Environments", Int. J. Environ. Res. Public Health, PP. 595-610.

<sup>2</sup> A.A. Khan, 1999, "Risk Assessment in Petrochemical Industry", First International Seminar SAFE 99 on Safety and Fire Engineering, Kochin, India, November, 24-26, 1999, PP.45-48.

underscores the importance of proper Health, Safety and Environmental (HSE) risk management. The BP Deepwater Horizon disaster serves as a reminder that HSE risk management should be an ongoing process that involves the constant management of knowledge and efficiency. It is crucial for the industry to adopt a proactive approach to HSE risk management, rather than a reactive one, to prevent such disasters from occurring in the future. This approach involves the use of advanced technologies and the application of data analytics to identify potential risks and take proactive measures to mitigate them before they escalate into disasters<sup>3</sup>.

Moreover, the oil and gas industry is facing increasing pressure to prioritize Health, Safety, and Environmental (HSE) risk management as a crucial aspect of their operations<sup>4</sup>. The industry's stakeholders, including workers, governments, and communities, are demanding world-class performance and operational excellence to prevent accidents and minimize the impact of any misfortune. The use of technology and big data can significantly improve HSE risk management, and companies should constantly develop, commit, monitor and improve every area of HSE as part of their organizational culture. The industry also faces a shortage of technical specialists and an aging workforce, and the demand for petroleum engineers with HSE focus is expected to increase. As the industry continues to prioritize HSE, it will create awareness and a safety culture to improve the health and safety of its workers and the environment. Environmental Health Safety professionals play a critical role in ensuring the safety of workers and the public in various industries. They analyze risks and provide recommendations for managing dangers while adhering to regulations<sup>5</sup>.

The course "Risk Management in the Petroleum Industry" is designed for beginners and serves as an introduction for petroleum engineering students to various technical departments of Environmental Health and Safety within petroleum companies. A recent study conducted, highlighted the lack of inter-personal skills among most engineers in the industry. To address this issue, the course focuses on developing skills such as safety awareness, communication, unconventional problem solving, and ethical responsibilities. In addition, the course aims to cultivate a safety culture by covering Environmental Health and Safety awareness topics and expanding students' understanding of the oil and gas industry. An Occupational Safety and Health Administrator (OSHA) expert will provide hands-on training to students on the proper use of different personal protective equipment in emergency situations. The personal safety aspect of the course covers essential topics such as human factors in executing tasks on-site, working at heights, and confined space entry<sup>6</sup>.

HSE professionals can work in various units, including research and technology institutions, public sectors, and state agencies, and can contribute to emergency response and crisis management teams. Due to the high risk of accidents in the chemical processing and petroleum industries, there

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3 A.A. Aliyund S. Saidu, 2011, "Pattern Of Occupational Hazards And Provisions Of Occupational Health Services And Safety Among Workers Of Kaduna Refinery And Petrochemical Company Ltd (KRPC), Kaduna, Nigeria", *Continental J. Tropical Medicine*, 5 (1), PP.1- 5, 2011

4 Badrul Islam, 2015, "Petroleum Sludge, Its Treatment and Disposal: A Review", *Int. J. Chem. Sci.*, 13(4), PP. 1584- 1602.

5 Faith Eyayo, 2014, "Evaluation of Occupational Health Hazards among Oil Industry Workers: A Case Study of Refinery Workers", *IOSR Journal of Environmental Science, Toxicology and Food Technology*, 8(12), Ver. I (Dec. 2014), PP. 22-53.

<sup>6</sup> Adei, D. & Kunfaa, E. Y. (2007). Occupational Health and Safety Policy in the Operations of the Wood Processing Industry in Kumasi, Ghana. *Journal of Science and Technology*, 27 (2), 163 – 171.

is a significant demand for HSE engineers in these industries. The aviation and commercial aircraft industries also require HSE engineers to ensure safety during the airplane manufacturing process, luggage handling, and other related aviation activities. The nuclear power industry, with its complex operations and potential risks, greatly benefits from the knowledge and expertise of HSE professionals, who work to prevent accidents and promote a safe working environment<sup>7</sup>.

### **Goal of Occupational Safety and Health Risk Management in the Oil and Gas Industry**

The goal of occupational safety and health (OSH) risk management in the oil and gas industry is to identify and assess potential hazards and risks to workers' health and safety, and to implement controls to prevent or minimize these risks. This is done to ensure that workers are able to work in a safe and healthy environment, and to reduce the likelihood of accidents, injuries, and illnesses. The OSH risk management process in the oil and gas industry typically involves several steps, including hazard identification, risk assessment, risk prioritization, risk control, and ongoing monitoring and evaluation.<sup>8</sup> This process is designed to systematically identify and address hazards and risks in the workplace, and to ensure that appropriate controls are in place to mitigate these risks. The ultimate goal of OSH risk management in the oil and gas industry is to create a culture of safety and health in which workers are empowered to identify and report hazards, and to actively participate in the development and implementation of safety and health programs. By promoting a proactive approach to safety and health, companies in the oil and gas industry can reduce the likelihood of accidents and injuries and ensure that workers are able to work in a safe and healthy environment<sup>9</sup>.

### **EHS Management in the Oil and Gas Industry: a Road Map to Success?**

EHS (Environmental, Health, and Safety) management is a critical component of success in the oil and gas industry. Effective EHS management helps to ensure that companies in the industry are able to operate in a safe, environmentally responsible, and sustainable manner, while also meeting their business goals. The EHS roadmap to success in the oil and gas industry typically involves several key steps. These includes: - Setting clear EHS objectives: Companies in the oil and gas industry must establish clear and measurable EHS objectives that are aligned with their overall business goals<sup>10</sup>. Developing EHS policies and procedures: Companies must develop robust EHS policies and procedures that provide guidance on how to identify and manage risks, as well as how to comply with applicable laws and regulations. Implementing EHS training programs: Companies must provide regular training to employees and contractors on EHS policies, procedures, and best practices to ensure that everyone is aware of their roles and responsibilities. Conducting regular EHS audits: Regular EHS audits help to identify potential areas of risk and to ensure that EHS policies and procedures are being followed. Continually improving EHS performance: Companies must continually review and improve their EHS performance to ensure

<sup>7</sup> Oppong, S. (2011). Health & Safety: Theory and Practice in the Oil and Gas Sector. Saarbrücken, Germany: VDM Publishing House Ltd (ISBN: 978-3-639- 36220-6).

<sup>8</sup> Oil & Gas Agenda: The health monitor: Occupational health, 2015, <http://www.growthmarketoil.com/features/featurethe-health-monitor-occupational-health-4622752/> [accessed 9 Oct. 2015].

<sup>9</sup> ILO: 10 keys for gender sensitive OSH practice – Guidelines for gender mainstreaming in occupational safety and health (Geneva, 2013).

<sup>10</sup> Spurgeon, A. & Cooper, C. L. (2000). Working Time, Health, and Performance. International Review of Industrial and Organizational Psychology, Vo. 15, 189 – 222.

that they are meeting their objectives and that they are keeping pace with changing industry trends and regulations. By following this roadmap, companies in the oil and gas industry can achieve success by protecting their employees, minimizing environmental impacts, and maintaining a strong reputation for responsible and sustainable operations. Effective EHS management can also help companies to reduce costs, improve efficiency, and enhance their overall business performance<sup>11</sup>.

### **The Application of Data Analytics to Identify Potential Risks in the Oil and Gas Industry**

Data analytics can be used to identify potential risks in the oil and gas industry by analyzing large volumes of data from various sources<sup>12</sup>. Here are some ways that data analytics can be applied:

1. **Predictive maintenance:** Predictive maintenance is a proactive approach that leverages advanced technologies and data analysis to anticipate and prevent equipment failures before they occur. By collecting and analyzing real-time data from sensors, predictive maintenance algorithms can identify patterns and trends to forecast potential breakdowns or performance degradation. This enables timely interventions, such as scheduling maintenance activities or replacing parts, to minimize unplanned downtime and optimize asset utilization. Predictive maintenance not only reduces costs associated with reactive repairs but also enhances operational efficiency, improves safety, and extends the lifespan of critical machinery. It empowers organizations to shift from a reactive to a predictive maintenance strategy, maximizing productivity and customer satisfaction. **Risk modeling:** Data analytics can be used to develop models that identify and quantify risks associated with specific activities or equipment. This information can be used to prioritize safety efforts and investments.
2. **Safety monitoring:** Safety monitoring involves the continuous surveillance and assessment of various factors to ensure the well-being and protection of individuals, environments, or assets. It utilizes advanced technologies, such as sensors, cameras, and data analytics, to detect and mitigate potential risks or hazards. Safety monitoring systems can monitor parameters like temperature, pressure, motion, or gas levels in real-time, providing early warnings and alerts for immediate action. By proactively identifying and addressing safety issues, organizations can prevent accidents, minimize injuries, and safeguard both personnel and property. Safety monitoring plays a crucial role in industries such as manufacturing, construction, transportation, and healthcare, where maintaining a secure and risk-free environment is paramount.
3. **Environmental monitoring:** Environmental monitoring involves the systematic collection and analysis of data to assess and understand the state of the environment. It encompasses various factors like air quality, water quality, noise levels, biodiversity, and climate conditions. Monitoring methods can range from manual sampling to automated sensor networks, enabling continuous and accurate data collection. Environmental monitoring provides crucial information for assessing the impact of human activities, identifying pollution sources, and evaluating the effectiveness of conservation efforts. It helps in

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<sup>11</sup> The Promotional Framework for Occupational Safety and Health Convention, 2006 (No. 187), Art. 1(d).

<sup>12</sup> The E&P Forum/ UNEP (1997). Environmental management in oil and gas exploration and production: An overview of issues and management approaches. UNEP IE/PAC Technical Report 37 (Paris)/E&P Forum Report 2.72/254 (London): Authors.

detecting environmental changes, predicting trends, and formulating strategies for sustainable development and resource management. By monitoring the environment, we can make informed decisions to protect ecosystems, mitigate pollution, and promote a healthier and more resilient planet.<sup>13</sup>

4. **Incident analysis:** Incident analysis involves the systematic examination of events, incidents, or accidents to identify their causes, contributing factors, and underlying issues. It aims to understand what happened, why it happened, and how similar incidents can be prevented in the future. Incident analysis typically involves gathering and analyzing data, conducting interviews, reviewing documentation, and using various analytical techniques. By identifying root causes and systemic weaknesses, organizations can implement corrective actions and preventive measures to enhance safety, efficiency, and performance. Incident analysis is vital in industries such as aviation, healthcare, manufacturing, and transportation, where learning from past incidents is crucial for continuous improvement and risk mitigation.

By applying data analytics to identify potential risks, the oil and gas industry can proactively address safety and environmental concerns, reducing the likelihood of accidents and improving overall operational efficiency.

### **How Can Oil and Gas Professionals Overcome Hazards and Health Problems Faced in the Industry?**

Oil and gas professionals can take several steps to overcome the hazards and health problems they face in the industry.<sup>14</sup> Here are a few suggestions:

1. **Implement strong safety protocols:** To ensure a safe working environment, it is essential to implement strong safety protocols. This includes developing comprehensive safety policies and procedures, conducting regular training and awareness programs, providing appropriate personal protective equipment, and promoting a culture of safety. Regular inspections, audits, and risk assessments should be conducted to identify and address potential hazards. Additionally, fostering open communication channels and encouraging employees to report safety concerns or near misses are crucial. By implementing robust safety protocols, organizations can minimize accidents, protect employees, and create a safer and healthier workplace.
2. **Prioritize health and wellness:** Prioritizing health and wellness involves placing a high emphasis on promoting and maintaining the well-being of individuals. This includes providing access to healthcare resources, encouraging healthy lifestyle choices, offering wellness programs, and creating a supportive and inclusive environment that values physical, mental, and emotional health.
3. **Address ergonomic risks:** Addressing ergonomic risks involves identifying and mitigating factors that can cause musculoskeletal disorders and discomfort in the workplace. This includes evaluating workstations, adjusting furniture and equipment to promote proper posture, providing ergonomic training, and implementing ergonomic

<sup>13</sup> HSE: Key Programme 3: Asset Integrity Programme O D HSE Hazardous Installations Directorate (London, 2007), p. 7.

<sup>14</sup> Parkes, K. R. (2010). Offshore working time in relation to performance, health and safety: A review of current practice and evidence. Research Report RR772 Prepared by the University of Oxford for the Health and Safety Executive.

guidelines. By addressing ergonomic risks, organizations can reduce the incidence of injuries, improve employee comfort and productivity, and create a healthier and more ergonomic work environment.

It is important for companies to prioritize the health and safety of their employees by implementing strong safety protocols, prioritizing health and wellness, and addressing ergonomic risks, to improve worker safety and health. By doing so, oil and gas professionals can overcome the hazards and health problems they face in the industry<sup>15</sup>.

### **How to Use Advanced Technologies in Mitigating Hazards in the Oil and Gas Industry**

Advanced technologies can play a significant role in mitigating hazards in the oil and gas industry. Here are some ways oil and gas professionals can use advanced technologies to reduce risks and improve safety<sup>16</sup>:

1. **Remote monitoring and control systems:** Remote monitoring and control systems enable the real-time monitoring, management, and control of devices, systems, or processes from a remote location. These systems utilize advanced technologies such as sensors, Internet of Things (IoT), and cloud computing to gather data and provide remote access and control capabilities. Remote monitoring and control systems offer numerous benefits, including increased operational efficiency, reduced downtime, improved safety, and cost savings. They allow for proactive monitoring, timely response to issues, and remote adjustments or troubleshooting. Industries such as manufacturing, energy, healthcare, and transportation heavily rely on these systems to monitor assets, optimize performance, and streamline operations even from a distance.
2. **Drones:** Drones, also known as unmanned aerial vehicles (UAVs), are aircraft without a human pilot on board. They have gained significant popularity and applications in various industries. Drones are equipped with cameras and sensors that enable them to capture aerial imagery, perform inspections, monitor infrastructure, and assist in search and rescue operations, inspect and monitor pipelines, tanks, and other equipment without putting workers at risk. They offer advantages such as cost-efficiency, accessibility to remote or hazardous areas, and rapid data collection. Drones are used in sectors like agriculture, construction, filmmaking, and surveillance. As technology advances, drones continue to revolutionize industries by providing efficient and versatile aerial capabilities.
3. **Virtual and augmented reality:** Virtual and augmented reality (VR/AR) are immersive technologies that provide users with interactive and simulated experiences. VR creates a completely virtual environment, while AR overlays digital content onto the real world. These technologies can be used for training and simulation, allowing workers to practice and prepare for hazardous situations in a safe environment.
4. **Wearable technology:** Wearable technology refers to electronic devices or sensors that can be worn on the body, typically as accessories or clothing. These devices, such as smartwatches, fitness trackers, and smart glasses, offer features like activity tracking, heart

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<sup>15</sup> “Cost cutting jeopardizes North Sea rigs: Union hits at oil and gas industries over under reporting of offshore accidents” (review with K. Scott), in *The Guardian*, 26 Apr. 2004, p. 11.

<sup>16</sup> Schouwenaars, E. (2008). *The Risks Arising from Major Accident Hazards: Lessons from the Past, Opportunities for the Future*. Retrieved October 4, 2009 from World Wide Web: [http://www.dnv.nl/Binaries/Paper%20Refining%20Management%20Forum%20Copenhagen\\_tcm141-311567.pdf](http://www.dnv.nl/Binaries/Paper%20Refining%20Management%20Forum%20Copenhagen_tcm141-311567.pdf)

rate monitoring, communication, and access to information. Wearable technology has gained popularity for its ability to provide real-time data, promote health and fitness, and enhance convenience and connectivity in everyday life. Wearable devices can monitor worker health and safety in real-time, alerting workers and supervisors to potential hazards and risks.<sup>17</sup>

5. **Artificial intelligence:** Artificial intelligence (AI) refers to the simulation of human intelligence in machines that can analyze data, learn from patterns, and make intelligent decisions. It encompasses various techniques such as machine learning, natural language processing, and computer vision. AI is used in diverse fields, including healthcare, finance, transportation, and customer service, where it enables automation, prediction, and problem-solving. AI's potential to revolutionize industries and improve efficiency makes it a key area of research and development with vast implications for the future. AI can be used to analyze data from sensors and other sources to identify potential hazards and predict equipment failures, allowing for preventative measures to be taken.

By utilizing these and other advanced technologies, oil and gas professionals can better identify and mitigate hazards, improving safety and reducing the risk of accidents and injuries.

### **Risk Assessment by HSE Professionals**

Risk assessment is a critical function of HSE professionals in the oil and gas industry<sup>18</sup>. The risk assessment process involves identifying potential hazards in the workplace, evaluating the likelihood and severity of harm associated with those hazards, and developing strategies to control or eliminate those hazards. HSE professionals use a variety of tools and techniques to conduct risk assessments, including job safety analyses, hazard and operability studies (HAZOP), and failure modes and effects analyses (FMEA). They work closely with operations personnel to identify potential hazards and assess the effectiveness of existing safety controls. The goal of risk assessment is to prevent incidents from occurring by identifying and mitigating potential hazards before they can cause harm<sup>19</sup>. HSE professionals also play a critical role in developing emergency response plans and procedures to ensure that workers are prepared to respond in the event of an incident<sup>20</sup>. Risk assessment is a fundamental function of HSE professionals in the oil and gas industry, and it is essential for maintaining a safe and healthy work environment.

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<sup>17</sup> J. Bennet and P. Foster: "D industry-specific approach to a safety management system", in Policy and Practice in Health and Safety (2007, Vol. 5, No. 1), pp. 37–59; S. Bornstein and S. Hart: "E Occupational Safety and Health Management Systems", in Policy and Practice in Health and Safety (2010, Vol. 8, No. 1), pp. 61–76.

<sup>18</sup> IPIECA: Prevention of heart attacks and other cardiovascular diseases: A guide for managers, employees and company health professionals (London, 2013).

<sup>19</sup> ILO: Guidelines on occupational safety and health management systems, ILO–OSH 2001, 2nd edition (Geneva, 2009).

<sup>20</sup> International Labour Organization (2009). World Day for Safety and Health at Work 2009 Facts on Safety and Health at Work. Retrieved October 4, 2009, from the World Wide Web: [http://www.ilo.org/wcmsp5/groups/public/-/dgreports/dcomm/documents/publication/wcms\\_105146.pdf](http://www.ilo.org/wcmsp5/groups/public/-/dgreports/dcomm/documents/publication/wcms_105146.pdf)



### Steps in HSE Environmental Analysis

HSE environmental analysis is a process of evaluating the environmental impact of operations and identifying strategies to reduce the impact (Occupational Safety and Health Administration. (n.d.)). Here are the steps involved in HSE environmental analysis:

1. **Identify environmental hazards:** The first step is to identify environmental hazards associated with the operations, including emissions, waste generation, and resource consumption. HSE professionals use tools such as environmental audits, site assessments, and compliance reviews to identify potential hazards. Identifying environmental hazards involves recognizing and assessing factors or conditions in the environment that can pose risks to human health, ecosystems, or natural resources. This includes evaluating pollution sources, monitoring chemical or biological hazards, and identifying potential threats such as air pollution, water contamination, hazardous waste, or climate change impacts.
2. **Evaluate environmental risks:** Once environmental hazards have been identified, the next step is to evaluate the risks associated with those hazards. Evaluating environmental risks involves assessing the likelihood and potential consequences of hazards or activities on the environment. It includes analyzing factors such as pollutant emissions, ecosystem impacts, habitat destruction, and resource depletion. Through risk assessment, organizations can make informed decisions, implement mitigation measures, and prioritize environmental protection and sustainability. HSE professionals use quantitative and qualitative risk assessment methods to evaluate the likelihood and severity of harm associated with the hazards.
3. **Develop strategies to reduce environmental impact:** Developing strategies to reduce environmental impact involves implementing measures and practices aimed at minimizing harm to the environment. This includes initiatives like adopting renewable energy sources, implementing recycling programs, reducing emissions, promoting sustainable practices, and employing eco-friendly technologies. By proactively addressing environmental concerns, organizations can contribute to a greener and more sustainable future. Based on the results of the risk assessment, HSE professionals develop strategies to reduce the environmental impact of operations. This may include implementing pollution prevention programs, improving energy efficiency, reducing waste, and conserving resources.<sup>21</sup>
4. **Implement environmental management systems:** Implementing environmental management systems (EMS) involves establishing a framework to systematically manage an organization's environmental responsibilities. This includes setting environmental objectives, conducting audits, implementing policies and procedures, and ensuring compliance with environmental regulations. EMS helps organizations identify and mitigate environmental impacts, promote sustainability, and improve overall environmental performance. HSE professionals work with operations personnel to implement environmental management systems that ensure ongoing compliance with environmental regulations and best practices. This includes developing policies and procedures, training employees, and conducting regular audits and inspections.
5. **Monitor and measure performance:** Finally, HSE professionals monitor and measure the performance of environmental management systems to ensure that they are effective in reducing environmental impact. Monitoring and measuring performance involves tracking

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<sup>21</sup> The Promotional Framework for Occupational Safety and Health Convention, 2006 (No. 187), Art. 1(d).

and evaluating key indicators to assess the effectiveness and progress of initiatives. This includes analyzing data, conducting audits, and utilizing metrics to evaluate performance against set goals and targets. Regular monitoring and measurement enable organizations to identify areas for improvement and make data-driven decisions to enhance performance and achieve desired outcomes. This includes tracking key performance indicators, conducting periodic assessments, and continually improving processes and procedures.

HSE environmental analysis is a critical process for identifying and managing environmental risks associated with operations in the oil and gas industry, and it plays a vital role in protecting the environment and promoting sustainability.

### **How HSE Professionals Bridge the Gap in the Oil and Gas Industries**

HSE professionals play a critical role in bridging the gap in the oil and gas sector by ensuring that health, safety, and environmental risks are managed effectively<sup>22</sup>. Here are some of the ways that HSE professionals bridge the gap in the oil and gas sector:

1. **Compliance with regulations:** HSE professionals ensure that oil and gas companies comply with regulatory requirements related to health, safety, and the environment. This includes monitoring and reporting on environmental impacts, implementing safety protocols, and maintaining records and documentation.
2. **Risk management:** HSE professionals conduct risk assessments and develop risk management strategies to reduce the likelihood and severity of incidents related to health, safety, and the environment. This includes identifying potential hazards, evaluating risks, and implementing controls to manage risks.
3. **Communication and collaboration:** HSE professionals work closely with stakeholders across the oil and gas sector, including management, employees, regulators, and community members. They facilitate communication and collaboration to ensure that health, safety, and environmental concerns are addressed effectively.
4. **Training and education:** HSE professionals provide training and education to employees on health, safety, and environmental issues. This includes providing training on safety protocols, hazardous materials handling, and emergency response procedures.
5. **Continuous improvement:** HSE professionals work to continuously improve health, safety, and environmental performance in the oil and gas sector. This includes identifying opportunities for improvement, implementing best practices, and conducting regular audits and assessments to ensure ongoing compliance and performance improvement.

However, HSE professionals play a critical role in bridging the gap in the oil and gas sector by ensuring that health, safety, and environmental risks are managed effectively, and by promoting communication, collaboration, and continuous improvement across the industry.<sup>23</sup>

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<sup>22</sup> Ghana Health Service/Ministry of Health (2002). Handbook on Occupational Health. Accra, Ghana: Authors.

<sup>23</sup> S. Antonsen et al.: "The role of standardization in safety management: A case study of a major oil & gas company" in Safety Science, 2012 Vol 50 Issue 10 pp. 2001-2009

**Hazards and Health Problems Faced by HSE Professionals** Oil and gas professionals face a range of hazards and health problems in the industry, including<sup>24</sup>:

1. **Physical hazards:** Physical hazards refer to the tangible factors or conditions in the environment that can cause harm or injury to individuals. These hazards include but are not limited to slippery surfaces, falling objects, noise, extreme temperatures, radiation, and electrical hazards. They can occur in various settings such as workplaces, public spaces, and homes. Identifying and mitigating physical hazards through proper safety measures, equipment maintenance, and training is crucial to ensure the well-being and safety of individuals and minimize the risk of accidents or injuries.
2. **Chemical hazards:** Chemical hazards refer to substances or mixtures that have the potential to cause harm to human health or the environment. These hazards can be found in various forms, including toxic gases, flammable liquids, corrosive materials, and carcinogens. Exposure to chemical hazards can lead to acute or chronic health effects, such as respiratory issues, skin irritation, or even long-term illnesses. Proper handling, storage, and labeling of chemicals, as well as implementing safety protocols and providing adequate personal protective equipment, are essential in mitigating the risks associated with chemical hazards and ensuring the safety of individuals and the environment. Oil and gas professionals may be exposed to hazardous chemicals, such as hydrocarbons, acids, and solvents, which can cause skin and eye irritation, respiratory problems, and other health issues. Exposure to these chemicals may occur through inhalation, ingestion, or skin contact.
3. **Biological hazards:** Biological hazards refer to living organisms or their byproducts that can cause harm or illness to humans, animals, or the environment. These hazards include bacteria, viruses, fungi, parasites, and toxins produced by organisms. Exposure to biological hazards can occur through contact with contaminated surfaces, ingestion of contaminated food or water, or inhalation of airborne particles. Preventive measures such as proper hygiene practices, vaccination, use of personal protective equipment, and implementing effective waste management are vital in reducing the risk of biological hazards and safeguarding public health. Oil and gas professionals may be exposed to biological hazards, such as bacteria and viruses, which can cause illnesses, such as respiratory infections and other communicable diseases.
4. **Radiation hazards:** Radiation hazards involve exposure to ionizing or non-ionizing radiation that can have harmful effects on human health and the environment. Sources of radiation hazards include X-rays, nuclear materials, ultraviolet radiation, and electromagnetic fields. Proper shielding, monitoring, and adherence to safety guidelines are essential in minimizing the risks associated with radiation hazards and protecting individuals from its harmful effects. Workers in the oil and gas industry may be exposed to ionizing radiation from sources such as naturally occurring radioactive material (NORM), which can cause cancer and other health problems.<sup>25</sup>

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<sup>24</sup> International Labour Organisation (2005). Facts on Safety at Work. Retrieved October 4, 2009 from the World Wide Web: [http://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/documents/publication/wcms\\_067574.pdf](http://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/documents/publication/wcms_067574.pdf)

<sup>25</sup> J. Bennet and P. Foster: "D industry-specific approach to a safety management system", in Policy and Practice in Health and Safety (2007, Vol. 5, No. 1), pp. 37–59; S. Bornstein and S. Hart: "E Occupational Safety and Health Management Systems", in Policy and Practice in Health and Safety (2010, Vol. 8, No. 1), pp. 61–76.

5. **Mental health hazards:** Mental health hazards encompass factors or conditions that can negatively impact an individual's mental well-being. These hazards include chronic stress, workplace bullying, social isolation, traumatic events, and excessive workload. Recognizing and addressing mental health hazards through supportive environments, stress management programs, and access to mental health resources is crucial for promoting psychological well-being. Oil and gas professionals may experience stress, anxiety, and other mental health issues related to the high-pressure, high-stakes nature of the industry, long working hours, and working in remote locations away from family and support systems.
6. **Noise hazards:** Noise hazards refer to excessive or prolonged exposure to high levels of noise that can cause hearing damage and other health effects. These hazards can occur in various settings such as workplaces, construction sites, and entertainment venues. Implementing noise control measures, providing hearing protection, and conducting regular noise assessments are important in mitigating the risks associated with noise hazards and protecting individuals' hearing health. Workers in the oil and gas industry may be exposed to high levels of noise, which can cause hearing loss and other hearing-related health issues.
7. **Musculoskeletal disorders:** Musculoskeletal disorders (MSDs) are conditions that affect the muscles, bones, tendons, ligaments, and other supportive structures in the body. They can result from repetitive movements, awkward postures, or excessive force. Preventive measures, such as ergonomic interventions, training, and proper work practices, are essential in reducing the risk of MSDs and promoting musculoskeletal health. Repetitive movements, heavy lifting, and awkward postures can cause musculoskeletal disorders, such as back pain, carpal tunnel syndrome, and tendinitis<sup>26</sup>.

It is important for oil and gas companies to identify and manage these hazards and health problems to ensure the safety and well-being of their workers. This may include providing appropriate personal protective equipment, implementing safety protocols and training programs, conducting regular risk assessments, and monitoring worker health and exposure to hazards.

### Case Studies of Hazards in the Oil and Gas Industries

Here are a few case studies of hazards in the oil and gas industry:<sup>27</sup>

#### 1. *Deepwater Horizon Oil Spill*

The Deepwater Horizon oil spill was an environmental disaster that occurred on April 20, 2010, in the Gulf of Mexico, off the coast of Louisiana, United States. It was caused by an explosion and subsequent fire on the Deepwater Horizon oil rig, which killed 11 workers and injured 17 others. The explosion also caused the oil rig to sink, resulting in the release of millions of barrels of oil into the Gulf of Mexico. Investigations revealed a failure of safety protocols and equipment, including blowout preventers, which were designed to prevent such incidents. The spill is considered one of the largest marine oil spills in history, and it had significant environmental and economic impacts. The oil affected marine life and ecosystems, as well as the livelihoods of those

<sup>26</sup> Health and Safety Executive (1997). "The costs to Britain of workplace accidents and work related ill health in 1995/1996". Sudbury: HSE Books.

<sup>27</sup> Y. Gan et al. "Shift work and diabetes mellitus: A meta-analysis of observational Studies " in Occupational and Environmental Medicine. 2014, Vol . 72, No. 1 July, pp. 72 –78

who rely on fishing and tourism in the affected areas. It also had economic impacts on the oil industry and related industries in the region. The cleanup effort was challenging and costly, and it took several months to contain the oil spill<sup>28</sup>. In addition to efforts to stop the leak and contain the oil, there were also efforts to mitigate the environmental damage and restore affected ecosystems. The long-term impacts of the spill are still being studied and assessed.



**Figure 1:** Deepwater Horizon oil spill <sup>29</sup>

## ***2. Piper Alpha Disaster***

The Piper Alpha disaster was a catastrophic oil rig explosion that occurred on July 6, 1988, in the North Sea, off the coast of Scotland. The incident resulted in the deaths of 167 people, including 165 workers on the oil rig and two crew members on a rescue vessel. The disaster was caused by a gas leak from a pump, which was not detected and ignited, causing a massive explosion and fire. The fire spread quickly, and the oil rig was engulfed in flames, causing it to collapse into the sea. The incident had significant impacts on the oil and gas industry, as well as on safety regulations and procedures<sup>30</sup>. It led to the development of new safety standards, emergency response plans, and risk assessment processes, which have since become standard practice in the industry. The disaster also led to changes in the way that safety is managed on offshore oil rigs, including improvements in training, communication, and safety equipment. It is widely regarded as one of the worst industrial accidents in history, and it serves as a tragic reminder of the importance of safety in high-risk industries<sup>31</sup>.

## ***3. Texas City Refinery Explosion***

The Texas City refinery explosion was a catastrophic industrial accident that occurred on March 23, 2005, at the BP Texas City refinery, located in Texas City, Texas, United States. The explosion

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<sup>28</sup> National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling (January 2011). *Deep Water: The Gulf Oil Disaster and the Future of Offshore Drilling*; Report to the President. Retrieved May 31, 2011 from <http://www.gpo.gov/fdsys/pkg/GPO-OILCOMMISSION/pdf/GPO-OILCOMMISSION.pdf>

<sup>29</sup> from [www.theguardian.com](http://www.theguardian.com)

<sup>30</sup> American Society of Safety Professionals (2021)

<sup>31</sup> Parkes, K. R. (2002). Part I: Review of Literature. In K. R. Parkes (Ed.) *Psychosocial aspects of work and health in the North Sea oil and gas industry: Summaries of reports published 1996 – 2001*. Research Report 002 Prepared by the University of Oxford for the Health and Safety Executive

resulted in the deaths of 15 workers and injured over 170 others. The explosion was caused by a hydrocarbon vapor cloud that ignited in the isomerization unit of the refinery, which was located near a blowdown drum. The resulting explosion and fire were massive, and they caused significant damage to the surrounding area. The incident had significant impacts on the oil and gas industry, as well as on safety regulations and procedures. It led to a reassessment of safety procedures and practices, and it resulted in increased scrutiny of the oil and gas industry by regulatory agencies. The Texas City refinery explosion highlighted the need for improved safety standards and practices, including better training for workers, improved communication, and enhanced safety equipment. It also emphasized the importance of proper risk assessments and emergency response plans in high-risk industries.

### **Case Studies of Hazards in the Oil and Gas Industries in Nigeria**

There have been several incidents of hazards in the oil and gas industry in Nigeria<sup>32</sup>, some of which are highlighted below:

#### ***1. Niger Delta Oil Spills***

The Niger Delta region of Nigeria has been plagued by oil spills for decades, causing widespread environmental devastation and harm to local communities. The spills are primarily caused by corrosion of pipelines and other infrastructure, sabotage, and operational accidents. The oil spills in the Niger Delta have had a significant impact on the local environment and the health and livelihoods of the people who live there. The spills have contaminated waterways, destroyed crops, and killed fish and other aquatic life. This has led to a loss of income for local fishermen and farmers, who rely on the natural resources of the region for their livelihoods. The oil spills have also caused health problems for the people who live in the region, including respiratory illnesses, skin rashes, and other health problems. In addition, the spills have had a negative impact on the cultural heritage of the people who live in the region, with many traditional practices and beliefs being threatened by the environmental devastation. Efforts have been made to address the issue of oil spills in the Niger Delta, including government and industry-led initiatives. However, progress has been slow, and many people in the region continue to suffer the consequences of the spills. The Niger Delta region remains a focal point for environmental activism and advocacy, with many local and international organizations working to raise awareness of the issue and push for greater action to be taken to address it.<sup>33</sup>

#### ***2. Gas Flaring***

Gas flaring is the process of burning off natural gas that is released during oil production. It is a common practice in the oil and gas industry and is used as a means of disposing of unwanted gas that is produced during oil extraction. However, gas flaring is a major environmental problem, as it releases large amounts of greenhouse gases into the atmosphere, contributing to climate change and air pollution. Gas flaring is particularly prevalent in Nigeria's Niger Delta region, which is one of the most oil-rich areas in the world. The practice has had a devastating impact on the

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<sup>32</sup> Jensen, O. C., Sørensen, J. F. L., Canals, M. L., Hu, J., Nikolic, N., & Mozer, A. A. (2005). Non-Fatal Occupational Injuries Related to Slips, Trips and Falls In Seafaring. *American Journal of Industrial Medicine*, 47:161 – 171.

<sup>33</sup> World Health Organization: Recommended Health based occupational exposure limits for selected vegetable dusts (Report of a study group). WHO Technical report series 1983; 684:35-49

environment and the health of local communities. The burning of gas releases carbon dioxide, methane, and other harmful pollutants into the atmosphere, leading to respiratory problems, acid rain, and other negative impacts on the environment. Efforts to reduce gas flaring in the Niger Delta have been ongoing for many years. The Nigerian government has set targets to reduce gas flaring, and companies operating in the region are required to pay fines for any flaring that exceeds certain limits. In addition, there have been efforts to capture and utilize the natural gas that is currently being burned off, either for industrial purposes or for electricity generation. Despite these efforts, gas flaring continues to be a major problem in the Niger Delta and other oil-producing regions around the world. Continued efforts are needed to reduce flaring and mitigate its impact on the environment and local communities. This can be achieved through the use of technology to capture and utilize natural gas, as well as through regulatory measures and the promotion of alternative energy sources.

### ***3. Oil Tanker Accidents***

Oil tanker accidents can have devastating consequences for both the environment and human health. These accidents can occur due to a variety of factors, including human error, mechanical failure, and adverse weather conditions. For example, in May 2020, an oil tanker exploded in Lagos, resulting in multiple fatalities and extensive damage to the surrounding area. When oil tankers run aground or collide with other vessels, they can release large amounts of oil into the surrounding waters, causing oil spills that can have far-reaching environmental and economic consequences. Oil spills can have a range of negative impacts on the environment, including the death of marine life and damage to coastal habitats. In addition, oil spills can have long-term effects on human health, as exposure to oil and its toxic components can lead to respiratory problems, skin irritation, and other health issues. To prevent oil tanker accidents, a range of safety measures are in place. These measures include regulations governing the design and operation of oil tankers, as well as training programs for crew members and the use of technology to monitor vessel movements and weather conditions. In addition, emergency response plans are in place to ensure a swift and effective response in the event of an oil spill. When oil tanker accidents do occur, it is important to act quickly to minimize the impact of the spill. This can involve containment measures to prevent the spread of oil, as well as efforts to clean up the spill and mitigate its effects on the environment and local communities. These efforts can involve a range of stakeholders, including government agencies, oil companies, and local communities.<sup>34</sup>

### ***4. Oil Rig Explosions***

Nigeria has had a long history of oil rig explosions, with many of them being caused by poor maintenance, equipment failure, or sabotage. These explosions have caused significant environmental damage, including oil spills and fires, and have also led to the loss of lives and injuries among workers. One of the most notorious oil rig explosions in Nigeria occurred on January 15, 2012, when a gas leak from a well operated by the Nigerian National Petroleum Corporation (NNPC) led to a massive explosion that killed at least 10 people and injured many others. In January 2012, an oil rig operated by Chevron in Nigeria exploded, resulting in the death of two workers and the injury of several others. The explosion occurred at the Gbaramatu oil field, which is located in the Niger Delta region of Nigeria. Another major oil rig explosion in Nigeria

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<sup>34</sup> Ione L. Taylor, 2004, "Methods of Exploration and Production of Petroleum Resources", *Geology*, 5, PP.1-7.

occurred on June 19, 2021, when a platform operated by the Nigerian oil company, the Nigerian Petroleum Development Company (NPDC), caught fire in the OML 20 oil field in Delta state. The fire reportedly started after a gas leak from one of the wells on the platform. The fire raged for several days, causing significant damage to the environment and leading to the evacuation of nearby communities. The Nigerian government has taken steps to improve safety standards in the oil and gas industry in the country, but more needs to be done to ensure that such incidents are prevented in the future. This includes better training and equipment for workers, improved regulation and oversight of the industry, and increased investment in infrastructure and safety measures.

### Health Hazards to Workers

The oil and gas industry in Nigeria poses a number of health hazards to workers. Some of these hazards include<sup>35</sup>: Exposure to toxic chemicals: Workers in the oil and gas industry are exposed to a range of toxic chemicals, including benzene, toluene, xylene, and hydrogen sulfide. Exposure to these chemicals can lead to respiratory problems, skin irritation, headaches, nausea, and even cancer. Physical injuries: Operations in the oil and gas industry involve heavy machinery, equipment, and tools, which can cause physical injuries such as fractures, burns, and cuts. Workers may also be at risk of falls, electrocution, and fires. Heat stress: The high temperatures and humidity in the Nigerian climate combined with the heat generated from oil and gas operations can lead to heat stress among workers. Heat stress can cause fatigue, heat stroke, and dehydration. Mental health issues: Working in the oil and gas industry can be stressful and demanding, which can lead to mental health issues such as anxiety and depression. Infectious diseases: Workers in the oil and gas industry may be exposed to infectious diseases, such as tuberculosis and hepatitis, due to poor living conditions, inadequate sanitation facilities, and exposure to contaminated water sources. Noise exposure: Workers in the oil and gas industry may be exposed to high levels of noise from drilling, blasting, and other operations. Prolonged exposure to high levels of noise can lead to hearing loss and other hearing-related problems. Musculoskeletal disorders: Workers in the oil and gas industry may be at risk of developing musculoskeletal disorders due to the repetitive nature of their work, awkward postures, and heavy lifting. However, the Nigerian oil and gas industry poses a range of health hazards to workers. To mitigate these hazards, it is essential to implement appropriate safety measures and provide workers with adequate training, protective equipment, and access to medical care. These incidents highlight the need for improved safety and environmental management practices in the oil and gas industry in Nigeria.

### Limitations of HSE Practices in the Oil and Gas Industries

Despite the important role of HSE practices in the oil and gas industry, there are several limitations that can hinder their effectiveness.<sup>36</sup> Some of these limitations include:

1. **Lack of implementation:** One of the major limitations of HSE practices is the lack of implementation by companies. Many companies have HSE policies and procedures in place, but fail to implement them effectively, which can lead to accidents and incidents.

<sup>35</sup> Associated Press: New safety rules proposed to curb oil train fires, 23 July 2014.

<sup>36</sup> Lamvik G M, Naesje P C, Skarholt K and Torvatn H. Paperwork, management and safety: towards a bureaucratization of working life and a lack of hands-on supervision. In: Martorell S, Guedes Soares C and Barnett J. Safety, reliability and risk analysis: theory, methods and applications. London: Taylor and Francis, 2009.



2. ***Insufficient training and education:*** HSE practices rely heavily on the knowledge and skills of workers, but if workers are not properly trained and educated on HSE practices, then the effectiveness of those practices is greatly reduced.
3. ***Inadequate funding:*** Implementing effective HSE practices can be costly, and some companies may not allocate sufficient resources to support HSE initiatives.
4. ***Complex regulatory environment:*** The oil and gas industry is subject to a complex regulatory environment, which can sometimes create confusion and make it difficult to implement HSE practices.
5. ***Resistance to change:*** Some workers and managers may resist changes to HSE practices, either due to a lack of understanding or a reluctance to change established work practices.
6. ***Limited availability of skilled HSE professionals:*** Finding and retaining skilled HSE professionals can be a challenge, particularly in developing countries where the oil and gas industry is expanding rapidly.

It is however important for companies in the oil and gas industry to address these limitations in order to maximize the effectiveness of their HSE practices and ensure the safety and well-being of their workers.

### **Recommendations for Best HSE Practices in the Oil and Gas Industries**

Here are some recommendations for best HSE practices in the oil and gas industries<sup>37</sup>:

1. ***Strong leadership commitment:*** The management of oil and gas companies must show a strong commitment to HSE practices by providing adequate resources, promoting safety culture and setting clear HSE objectives.
2. ***Regular risk assessments:*** Regular risk assessments should be conducted to identify potential hazards and risks in the workplace. The risk assessment should be reviewed regularly to ensure it remains current.
3. ***Adequate training:*** All employees should be trained on HSE policies, procedures, and best practices. Training should be ongoing, and refresher courses should be provided regularly.
4. ***Regular audits and inspections:*** Regular audits and inspections should be conducted to ensure compliance with HSE regulations and company policies. The results of audits and inspections should be used to identify areas for improvement.
5. ***Incident reporting and investigation:*** Incidents, near misses, and accidents should be reported and investigated to identify root causes and prevent similar incidents from occurring in the future.
6. ***Use of technology:*** Advanced technologies such as drones, sensors, and artificial intelligence can be used to detect and monitor potential hazards in real-time.
7. ***Contractor management:*** Contractors and subcontractors should be managed and supervised to ensure that they comply with HSE regulations and company policies.
8. ***Emergency response plan:*** A comprehensive emergency response plan should be in place to handle emergencies and minimize their impact.

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<sup>37</sup> Epstein, P. R. & Selber, J. (March 2002). Oil: A Life Cycle Analysis of Its Health and Environmental Impacts. Boston, Massachusetts, The Center for Health and the Global Environment, Harvard Medical School, Harvard University.

9. ***Continuous improvement:*** Continuous improvement of HSE practices should be a core value of the organization, with regular reviews to identify areas for improvement and implement corrective actions.
10. ***Collaboration and sharing of best practices:*** The industry should encourage collaboration and sharing of best practices across companies, to improve overall HSE performance in the industry.

## Conclusion

Health, Safety, and Environment (HSE) is a critical aspect of the oil and gas industry that helps to ensure the safety of personnel, protection of the environment, and the integrity of assets. The implementation of HSE practices can significantly impact the success of oil and gas operations by preventing incidents, reducing downtime, and enhancing productivity. The success of HSE in the industry depends on the adoption of a proactive approach that integrates risk management, regulatory compliance, and best practices. This involves the use of advanced technologies, such as data analytics and remote monitoring, to identify potential risks and ensure that all personnel are aware of the hazards involved in their work. The industry in Nigeria faces unique challenges, such as pipeline vandalism, oil spills, and security concerns that require a targeted approach to HSE. Some best practices for HSE in the oil and gas industry include effective communication, training and development programs, regular risk assessments, and continuous improvement initiatives. HSE is a critical factor in the success of the oil and gas industry, and its implementation requires a comprehensive and proactive approach that considers the unique challenges of the industry.