The Significance of Multidisciplinary Research in Driving Innovations and Breakthroughs
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# JOB SAFETY ANALYSIS (JSA) ON WASTE PROCESSING INDUSTRIES AND MEASURING RISK ON RISK METRIX

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**Abstract:** This study discusses that the waste processing sector holds great importance in tackling and alleviating environmental problems and it is closely related to many of the health risks pertaining to dangerous work that could harm the safety and health of its workforce. Job safety analysis (JSA) is put forward as a critical assessment tool for the measurement, assessment and control of health hazards in the waste processing industry this paper. Along with a well thought out JSA, the path of each task is dismembered into short specific steps to identify potential dangers at each phase and suggest ways to minimize risks in order to keep the workers safe. Biological agents, mechanical injuries, exposure to hazardous chemicals, are all examined. Organizations can combine JSA with engineering controls, PPE and training of employees to create a safer workplace. The significance of proactive hazard identification and prevention to favorably mitigate count risks, enhance productivity and drive sustainability in waste processing sector is highlighted in this study.

**Keywords:** Waste Processing Industry, Health Hazard Prevention, Job Safety Analysis (JSA), Occupational Safety, Risk Assessment, Hazard Mitigation, Toxic Exposure, Biological Contaminants, Ergonomic Risks, Personal Protective Equipment (PPE), Engineering Controls, Worker Safety, Sustainable Operations, Occupational Health Risks, Safety Training

**1. Introduction:** Waste processing sector is imperative for pedaling and degrading the environmental effect of waste could be disposed from households, industries and so on. However, workers in this sector are naturally subject to unhealthy hazards such as touching hazardous chemicals, biological agents or ergonomical trouble and the risk of a physical injury. If these risks are not controlled, they can lead to the development of serious occupational diseases, accidents and sometimes fatalities in the workplace. To realistically deal with these threats, then, health and safety need to be tackled from a proactive and systematic basis. One such technique is implementing assessment framework dependent on Job Safety

Analysis (JSA). JSA is a systematic process involving identification of potential hazards of certain tasks, and estimation of the risk associated to these hazards, and taking control measures to eliminate or minimize these risks. This strategy not only increases on worker safety, but also ensures compliance with regulatory requirements, and create an organization safety oriented culture. The aim of this paper is to analyse how a complete JSA-based evaluation can be made to avoid health hazards for the waste processing sector. The paper will deal with workplace hazards identification, JSA methodology, and application in mitigating risks, thus leading to a less risky and healthier workplace environment.

## 2. Literature Review:

**[1] Chizubem, B., Izuchukwu Chukwuma, O., Damola Victor, A., & Chinonso, I. (2024)** suggest that there is need for effective Health, Safety and Environmental (HSE) interventions within the high risk process industry. Since the process industry is characterized by complex operations and associated significant risk, the industry is prone to many safety requirements to protect personnel and operational environment. Various intervention measures such as engineering controls, administrative controls, PPE and behavioral change have been taken to manage critical risks of product leaks, fires, explosions, and mechanical failures. Admin controls include policies and procedures, whereas engineering controls are the physical change of equipment and infrastructure to keep risk to the lowest level. Behavioral interventions rely on safe practice attitudes and cultivation of safe practices among employees, whereas PPE represents individual protection against specific dangers. These strategies are found to be effective in **[2] Zhuoshi Huang, Jicui Cui, Abdoulaye Bor, Wenchao Ma , Ziyi Zhang , Zhi Qiao , Ziyang Lou , Johann Fellner (2024)** in terms of short-term safety improvements for workers and on longer terms in the aspect of health safety, and environmental (HSE) results. Through these interventions in combination, each has been customarily successful against individual facets of risk management. This synergistic method is able to improve overall safety performance and operational efficiency. These findings promote the need to include numerous safety measures to develop a safe working environment and to de risk as well as promote safety culture in the process industry. This study assesses the health risks from 96 waste to energy (WtE) plants in 30 cities over the Bohai Rim, China by using advanced simulation models including the Weather Research and the Forecasting (WRF) model and the California Puff (CALPUFF) model to map spatial distribution of pollutants generated from these facilities.

Disposal methods such as land filling and composting are currently employed, but each comes with its own environmental risks. Landfills can contaminate groundwater, and composting may release volatile

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organic compounds (VOCs). To combat these issues, government initiatives promote waste segregation, recycling, and scientific disposal methods. Public awareness campaigns further emphasize the importance of proper waste management. A strategic approach that includes infrastructure development and sustainable practices is essential for effective waste management in Indore, as the city continues to grapple with the challenges posed by its growing population and waste complexity. Assessment was made by calculating hazard indices (HI) and cancer risks (CR) based on the methods of US Environmental Protection Agency. Results showed that generally, HI and CR are generally rather low, below accepted criteria, but were dependent on location and type of WtE plant. The health concerns were investigated in addition to variables such as operational conditions and waste the structure that impact health related variables. The health implications of emissions from WtE plants were strongly illustrated and indicated that things such as the efficient waste sorting with the use of latest technology and higher chimneys would have a significant decrease in the health risks arising from emissions from the WtE plants. This study is helpful from the standpoint that it provides important information on health effects of WtE plants in the Bohai Rim: an industry expert and regulatory agency manual. It emphasizes that, to ensure public health and support sustainable development, research must continue and best practice applied in the operation of WtE plants. With the rapid population growth in Indore's metropolitan areas, municipal solid waste (MSW) has become more urgent to be managed, according to **[3] Chetanya Mandecha, Jay Vyas, Mahesh Badole, Savan Awashya, Urvashi Mahajan (2024).** Indore's population stands at over 1.9 million and they have had to confront with the high rate and complexity of waste generation process. Related to this waste, the Municipal Corporation of Indore is responsible for reducing and disposing of such waste in an effective manner, i.e. in a system which would include various stages: generation, collection, transportation and disposal. However, urban hygiene is maintained by structured collection and transportation systems to prevent the environmental degradation while there is a need for continuous improvements.

In **[4] A study by Ali Isa and Abubakar Lawan Gajerima (2024),** assesses the attitudes of the professional health personnel to hygiene practices in the University of Maiduguri Medical Centre. Data was collected through self administered questionnaires from 200 participants of which 73.08% were students enrolled (n = 145) and 26.92 % who held staff positions (n = 55). The 70 percent who said health personnel had good hygiene and patient care attitudes did not completely agree, arguing cases of poor hygiene practices. This dissent emphasizes the significance of addressing even small lapses in hygiene when it comes to healthcare because it is so important to it. This paper argues that hygiene practices are related to healthcare performance through attitudes and their impact on hygiene practice: positive attitudes are associated with safety and satisfaction of patients whereas negative attitudes can be harmful. The study recommends that in order to overcome these challenges, the watchman should be supervised, surveillance technologies used, and other regular awareness session on hygiene and work ethics. It also asks for full zero tolerance for negligence towards hygiene. The study emphasizes the importance of continuous improvement in hygiene standards to ensure patient safety and efficient working of healthcare institutions. Due to inadequate infrastructure in small island developing states**, [5] Laisa Matagi , Delmaria Richards , Helmut Yabar , Takeshi Mizunoya , Gia Hong Tran , Christian Toochukwu Ogbonna (2024)** Solid waste management in households is a challenge for the small island developing states like Fiji. This study applies the waste characterization survey (WACS), life cycle assessment (LCA), and geographic information system (GIS) to analyses the present waste management practices in Nasinu Town Council to identify the suitable waste treatment facilities. The paper analyzes several means of improving solid waste management, such as solid waste recycling of inorganic waste and conversion of organic waste to energy. It is worth noting that landfill gas recovery is a primary strategy to reduce this type of emission. This implies organic waste has to be processed to increase environmental health, reduce the volume of waste going into the landfill, and decrease pollutant emissions. It concludes by stating the importance of supportive policies for solid waste management and illustrates how organic waste treatment can improve practices in Nasinu Town. The study also points out that strong rules and state of the art technologies are needed to have effective waste management. This study provides a paradigm which offers practice-based insights and reproducible technologies that are not only applicable in Nasinu Town but also the broader Pacific Region. These strategies aim at improving SIDS' solid waste management practices and may contribute significantly to environmental sustainability and public health through implementation. The study as a whole point out the important problems that need to be solved and the possibility to make improvements regarding the management of solid waste in small island developing states as well as stating that innovations and supportive policies are required**. [6] E. Gallego, J.F. Perales, N. Aguasca, R. Domínguez (2024)** The accurate assessment of landfill impacts underpins on the use of reliable emission source data, as often in environmental studies. An indirect approach is presented in this research as a methodology to characterize the emission profiles of a variety of landfill sources in order to determine emission factors using air concentrations in ambient air with emphasis on $H_2S$, $NH_3$, and VOCs and the

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Can Mata landfill in the Hostalets de Pierola, Catalonia, Spain. The sampling was generally carried out in dumping zones, premised closed sites, and leachate reservoirs. The quantities of $H_2S$ and $NH_3$ were measured using Radiello passive samplers, while VOCs were measured using Tenax TA tubes and multi-sorbent beds, which were then analyzed by TD-GC/MS. TVOC values were found to be the lowest in the leachate reservoirs (0.3–0.6 mg/m³) & pre c get Value counted c runs Area time areas (77–165 µg/m³) and the highest in the dumping locations (0.7–3.5 mg/m³). Highest amount of $H_2S$ and $NH_3$ were also observed in the leachate reservoir, i.e. up to 1.1 mg/m³ and 1.8 mg/m³ respectively. Odour thresholds were employed to identify the key compounds contributing to odour nuisances, in order to measure odour irritation. $H_2S$ was the main contributor to O.U.'s in the leachate reservoirs, and VOCs to O.U.'s of the disposal locations and they showed the largest O.U.'s. Ambient air concentrations were numerically used to calculate emission factors of TVOC, $H_2S$ and $NH_3$ using an Eulerian dispersion model. TVOC, $H_2S$ and $NH_3$ emitted from the sources varied from 0.44 g/s to 10.9 g/s, 0.16 g/s to 1.02 g/s and 0.23 g/s to 1.82 g/s, respectively. The importance of the precise emission factors for the creation of the landfill impact maps, which are necessary for good landfill management, is also pointed out in this study. The outlined comprehensive method is valuable as it gives useful information on landfill emissions and the need of accurate data for effective and reliable environmental impact management. Solid waste disposal, in particular when not properly managed, is not only an environmental but also a health risk and it is therefore equally problematic as described in Asella Town by **[7] Amde Eshete, Alemayehu Haddis, Embialle Mengistie (2024).** This paper aims to investigate the bad effects of improper waste management on a community that involves health problems and pollution. Data and analysis were collected and performed by a cross-sectional design and binary logistic regression model on environmental and health outcomes via house-to-house survey of a random sample of 418 household. The study revealed significant environmental impacts, with water pollution (34.2%), air pollution (31.6%), and soil pollution (13.4%) being major concerns. Health impacts included high rates of respiratory diseases (49.5%), bronchitis (18.2%), diarrheal illnesses (15.8%), and protozoan diseases (14.8%). A correlational analysis indicated that reusing solid waste significantly reduced health risks (AOR = 7.90, 95% CI: 2.12–29.42). Additional factors, such as education levels, homeownership, and income, were also linked to varying health outcomes. The study concludes that Asella Town's waste management issues require immediate attention. Implementing waste reduction, reuse, and recovery strategies, alongside professional interventions and stronger government policies, is essential for mitigating environmental degradation and protecting public health.**[8] Giovanni**

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**Vinti , Valerie Bauza , Thomas Clasen , Terry Tudor , Christian Zurbrügg , Mentore Vaccari (2024)** In this study, the potential health risks from 96 waste to energy (WtE) plants in 30 cities of the Bohai Rim in China, are analyzed with advanced pollution models, the Weather Research and Forecasting (WRF) and California Puff (CALPUFF), to determine the areas polluted by pollutants. According to US Environmental Protection Agency guidelines, hazard indices (HI) and cancer risks (CR) were calculated. Results revealed that HI and CR were generally low and much lower than the established limits, with average values of $2.95 \times 10^{-3}$ and $3.43 \times 10^{-7}$, however, plant species and location contributed to the variation. In the study, some factors, including waste composition, moisture content and operational circumstances influence health problems. Practical solutions to attenuate these risks were recommended to be greater chimney heights, more expensive construction for advanced technology, and the efficient sorting of wastes. In general, these findings will be helpful for regulatory bodies and company managers to improve municipal solid waste (MSW) management and carry out sustainable development activities, and also give them essential inputs concerning the adverse health effects of WtE plants in Bohai Rim. It also emphasizes the need for continuing monitoring and implementing best practices to keep the WtE operations sustainable and safe. [**9] Francesca Demichelis, Carola Martina, Debora Fino, Tonia Tommasi, Fabio A. Deorsola (2023)** 45,000 Mt of waste of absorbent hygiene products (AHPs) worldwide were produced, and methods of disposal (landfilling and incineration) resulted in a raise of greenhouse gas emissions and an economic problem. This study uses Life Cycle Assessment (LCA) to evaluate the environmental impacts of four Waste treatment methods of AHP: mechanical thermal conversion to fluff, biological processing, material recovery using recycling, and baseline case of landfilling and energy recovery from incineration. The functional unit used for comparison was one tonne of AHP waste, collected to final disposal, taking into account risk to human toxicity, climate change and non-renewable energy use based on the ReCiPe 2016 Midpoint (H) method. Its treatment efforts were even out compensated since recycling of resources was recovered. As a result, the AHP waste was decreased by 2.68 kg $CO_2$ eq./t AHP waste, 0.07 kg 1,4-DB eq./t AHP waste, and 26.36 MJ/t AHP waste. The mechanical-thermal treatment and the biological treatment obtained similar ratings but the mechanical-thermal treatment may be further improved by valorisation of the energy released by the resulting fluff. The sensitivity experiments show that balancing the treatment effort can be achieved only for high product recovery rates. The result of this study suggests that innovative waste management strategies should concentrate on the first step of recycling and recovering improved processes to minimise

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the disastrous consequences of AHP waste on the environment and economy. This review presents an overall assessment, of the current and emerging AHP waste treatment methods to guide the provision of more sustainable practise internationally.

**3. Methodology: Step 1:** Job Identification and Task Analysis Decompose work processes into distinct tasks. Rank tasks according to the severity of hazards and their frequency of occurrence.

**Step 2:** Hazard Identification Utilize methods such as site evaluations, employee interviews, and analysis of past incident records. Pinpoint specific health risks associated with each task step.

**Step 3:** Risk Assessment Evaluate risks based on factors such as probability, severity, and frequency. Use risk matrices to classify hazards as low, medium, or high.

**Step 4:** Implementation of Hazard Control Measures Make use of the hierarchy of control: Elimination/Substitution: Replace hazardous materials or processes with safer ones. Engineering controls: Install safety barriers, guards, and ventilation systems. Administrative Controls: Establish policies such as restricted access, work rotation, and shift scheduling. Personal Protective Equipment (PPE): Supply gloves, goggles, masks, and protective attire.

**Step 5:** Documentation and Communication Record the findings of the JSA, detailing identified hazards and control measures. Disseminate safety protocols to employees through training sessions and meetings.

**Step 6:** Monitoring and Review Continuously review and revise the JSA as tasks, processes, or regulations change. Integrate feedback from employees and insights from incident investigations to enhance the JSA.

**Advantages of JSA-Based Evaluation Proactive Risk Management:**

- **Enhanced Worker Safety:** Lowers the chances of workplace injuries and illnesses.
- **Regulatory Compliance:** Adheres to occupational health and safety regulations.
- **Improved Efficiency:** Optimizes operations by addressing risks that could disrupt workflows.
- **Employee Engagement:** Involves staff in safety planning, promoting a culture of accountability.

## 4. Findings

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Health hazard prevention within the waste processing sector can be effectively managed through the implementation of a thorough Job Safety Analysis (JSA). This methodology serves to pinpoint potential risks and offers practical recommendations for reducing workplace hazards. The following are essential findings and suggestions derived from a JSA-focused assessment for this sector:

1. **Recognized Health Hazards:** A comprehensive JSA has revealed several prevalent hazards associated with waste processing activities, including: Chemical Exposure: The presence of hazardous substances (such as ammonia, methane, and heavy metals) during the sorting and treatment of waste. Biological Hazards: Risks associated with exposure to pathogens found in biomedical or organic waste. Physical Hazards: Potential injuries resulting from heavy machinery, sharp objects, or falling debris. Ergonomic Hazards: Strain caused by repetitive tasks, improper lifting techniques, or awkward body positions. Respiratory Risks: The inhalation of dust, fumes, or other airborne pollutants. Noise Pollution: Extended exposure to elevated noise levels generated by machinery.

**JSA table of Incineration**

| Sub processes | Task | Hazards | Control Measures |
|---|---|---|---|
| Waste Feeding into Rotary Kiln | Waste in packets is loaded in cart dumper manually and cart dumper is put in chute, and ram pushes it into rotary kiln | Cut hazard | 1. Provision of proper illumination in the shed<br>2. Training on checking procedure and the manual segregation and handling<br>3. PPE (hand gloves (Neoprene gloves), gum boots, safety helmet, Cartridge masks |
| | | Over loading | 1. To create a level indication in the cart dumper until which the filling will happen<br>2. to set the maximum number of cut parts to be loaded |
| | | Ergonomic Hazard | 1. To avoid overreaching and entrapment,<br>2. Job rotation for the workers carrying out manual handling at regular intervals<br>3. Training on the lifting techniques and manual handling |

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| | | | |
|---|---|---|---|
| | | Slip & trip | 1.Barricade area on the other 3 sides to not allow any human movement .Unauthorized entries into the restricted area are prohibited.<br>2. Regular schedule housekeeping in the dumping area and demarcation of the area where the waste has to be kept.<br>3. Increase the lux level at the dumping area<br>3. PPE (hand gloves (neoprene gloves), gum boots, Dongri, safety helmet, Cartridge masks |
| | The left over waste is manually pushed into the chute with the help of a long rod (stuck / choke material) | Cut hazard | 1. Provision of proper illumination in the shed<br>2. PPE (hand gloves (Neoprene gloves), gum boots, Dongri,Goggles, safety helmet, Cartridge masks<br>3. Inspection for the road for visible corrosion or protruded surface |
| | Liquid waste is pumped from the main tank to the day tank and then into the rotary kiln, pumping with lancer, primary burning with burner | Corroded pipes-lack of maintenance | 1. Daily visual inspection for pipeline to avoid leaks<br>2. Repaint at scheduled interval<br>3. Schedules inspection and maintenance for the pipes<br>4. Housekeeping if any spillage occurs |
| Ash Handling | Ash generated from DB bottom, SDA bottom and from MCS bottom are collected in a designated area where water is added to the ash to cool. | Burn injury (Hot Ash) | 1. Fencing around the ash storage area.<br>2. Training on safe operation to be conducted<br>3. Heat resistance Suit and other PPEs as per PPE Matrix |
| | | Spills | 1. Enclosed trolley or container present on the rail that can be pulled and pushed after filled and emptied<br>2. Barricade the area to restrict pedestrian movement<br>3. Training to be provided on the procedure for usage of spill kit<br>4. Regular inspection to identify the condition of spill |

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| | | | |
|---|---|---|---|
| | | | kit equipment and the quantity of spill kit reagents condition of the jumbo bags, or containers before filling |
| | | Ergonomic hazard | 1. Enclosed trolley or container present on the rail that can be pulled and pushed after filled and emptied<br>2. Provision of drum vehicle or forklift for easy movement of the drums or mechanical aids<br>3. Training to be provided on the lifting techniques |
| | | Inhalation of Ash | 1. Cartridge half and full facemask (if exposed in dense dust)<br>2. Quarterly health check up for ash handlers |
| | The cooled Ash is manually loaded in trolleys | Exposure to the skin causing skin irritation | 1. Full body suits to be worn while ash handling<br>2. Place wheel mounted trolleys which runs on rails with dimension larger than the opening of the chute of DB1 |
| | | Manual handling | 1.Use trolley carts for shifting the materials.<br>2.Pack small quantity materials in drums for shifting . |
| | The container gets filled, it is loaded to the truck. | Overloading | 1.Empty and full vehicle Weight on Weighbridge<br>2. Continuous supervision<br>3. Training on importance of proper loading. |
| | After loading on the truck, it is transferred to the landfill area. | Collision | 1. Follow the speed limit in the plant premises.<br>2. Signage on speed limit to remind the operator and the tipper driver to go at a slow speed on rough or uneven terrain while loading.<br>3. Defensive driving training to be provided to the operator/driver.<br>4. Trained personnel/driver to operate truck. |
| | Lime and activated carbon obtained as a Bag-filter discharge should also be collected in a separate container | Health hazard | 1. Half yearly medical check up/ as deemed necessary by factories inspector and job rotation based on the exposure<br>2. Training to be provided on the effects of activated carbon & lime(refresher/induction)<br>3. PPE (hand gloves (neoprene gloves), gum boots, full hand industrial overall, safety helmet, Cartridge |

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| | | | |
|---|---|---|---|
| | and should be used in stabilization of hazardous waste.(Bag house, precipitators) | | masks(N100/R100/P100 (orange/teal))<br>4. Temporary barrication to the area to restrict unauthorised entry |
| | | Fall of the material | 1.Training on spill control to the operators<br>2. Inspect the any damage in Bag /Drums before filling .<br>3. Ensure the drums / bags while loading . |
| | | Ergonomic hazard | 1. Provision of drum vehicle or forklift for easy movement of the drums, mechanical aids to be used<br>2. Training to be provided on the lifting techniques |

JSA table of Landfill

| **Sub Processes** | **Task** | **Hazards** | **Control Measures** |
|---|---|---|---|
| Hazardous Waste Landfilling | The waste is dumped and levelled by JCB or excavator at the suitable location initially | Collision with other vehicle and personnel | 1. Swing alarm for the JCB<br>2. Presence of banksman for directing the movement of vehicle<br>3. Periodic checks on license for JCB operators and defensive driving training<br>4. Provide HI-VIS PPE for the operators and workers<br>5. Pre-operational checks before the start of JCB |
| | | Hydraulic failure - sudden collapse | 1. Fit the tipper hydraulic hose with burst protection<br>2. Mechanical block/props when working under the raised tipper body<br>3. Daily visual inspection for visible hydraulic leaks<br>4. Training |
| | | Health hazard | 1. half yearly Medical checksor as presumed by the factories inspector<br>2. Weekly job rotation<br>2. Training to be provided on the harmful effects of landfill waste<br>3. PPE (Safety helmet , safety shoes (Gum boots), Cover |

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| | | | |
|---|---|---|---|
| | | | all, respirator masks for waste direct dumping) to be provided |
| | | Toppling - uneven surfaces on the landfill | 1. Edges to be provided with retroreflective sticks to maintain a safe distance from the edges<br>2. Training to be provided on landfill profiling and route creation to the active sites<br>3 .Ensure that the rain water is collected through the storm water drains provisioned around the landfill |
| | Excavator and dozers are then used for levelling and compaction throughout the active site | Landfill (Falling of the steep) | 1. More than 3 or 4 vehicles should not be allowed to work on the same spot of operational landfill<br>2. Temporary retroreflective sticks to be provided along side the edge of active landfill and the routes to maintain a safe distance from the edges<br>3. Regular inspection of the load bearing roads and compaction wherever required.<br>Speed signages to be placed |
| | | Health hazard | 1. half yearly Medical checksor as presumed by the factories inspector<br>2. Weekly job rotation<br>2. Training to be provided on the harmful effects of landfill waste<br>3. PPE (Safety helmet , safety shoes (Gum boots), Cover all, respirator masks for waste direct dumping) to be provided |
| | | Collision | 1. Audio visual alarms/swing alarm should be functional for the dozers and the excavators<br>2. Temporary retroreflective sticks to be provided along side the edge of active landfill and the routes to maintain a safe distance from the edges<br>3. Use of temporary mobile lights along the route and active landfill |

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| | | | |
|---|---|---|---|
| | | | 4. PPE (Safety helmet , safety shoes (Gum boots), Cover all, respirator masks for waste direct dumping) to be provided |
| | Tarpaulin covering readily available while raining, operational landfill, current dumping spot | Health hazard | 1. half yearly Medical checksor as presumed by the factories inspector<br>2. Training to be provided on the harmful effects of landfill waste<br>3. PPE (Safety helmet , safety shoes (Gum boots), Cover all, respirator masks for waste direct dumping) to be provided |
| | | Ergonomic hazard | 1. Sufficient man power to be provided for pulling the sheets<br>2. Training to be provided on the ergonomics<br>3. PPE (Safety helmet , safety shoes (Gum boots), Cover all, respirator masks for waste direct dumping) to be provided |
| Landfill Inspection | Observation of any spillages at landfill area | Slip/trip | 1. Enforcement of gum boots<br>2. Avoid lone working at landfill sites<br>3. Constant communication through walkie-talkie<br>4. Training on first aid (snake bites) |
| | Check the movement of leachate | Pipes - corroded, blocked | 1. Lab testing to be done periodically of the leachate for corrosive nature<br>2. Daily visual inspection for any cracks<br>3. Keeping all the sources of ignition away from the leachate pipes |
| | | Health hazard | 1. half yearly Medical checksor as presumed by the factories inspector<br>2. Training to be provided on the harmful effects of leachate<br>3. PPE (Safety helmet , safety shoes (Gum boots), Cover all, respirator masks for waste direct dumping) to be provided |

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| | | | |
|---|---|---|---|
| | Check the leachate collecting sumps | Overfilled - spills | 1. Construction of secondary boundary walls to contain spills<br>2. Regular inspection of Alarm system for all the sumps or level meter indicating the height |
| | | Pipes - corroded, blocked, broken | 1. Lab testing to be done periodically of the leachate for corrosive nature<br>2. Daily visual inspection for any cracks<br>3. Keeping all the sources of ignition away from the leachate pipes |
| | | Electrocution | 1. Regular checking of the wiring system of alarm system and the pump system at the sumps<br>2. Regular inspection of the earthing of the pumps |
| | Landfill core sample testing will be done by lab department (density checking is done by picking out a sample) | Health hazard | 1. half yearly Medical checksor as presumed by the factories inspector<br>2. Training to be provided on the harmful effects of leachate<br>3. PPE (Safety helmet , safety shoes (Gum boots), Cover all, respirator masks for waste direct dumping) to be provided |
| | Core sample will be taken layer by layer to check the PH value and landfill strength | Slip/trip | 1. Enforcement of gum boots<br>2. Avoid lone working at landfill sites<br>3. Constant communication through walkie-talkie<br>4. Training on first aid (snake bites) |
| | | Collision with vehicle or machine | 1. Stop the operation during the time of sampling<br>4. PPE (Safety helmet , safety shoes (Gum boots), Cover all, respirator masks for waste direct dumping) to be provided |

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| | | | |
|---|---|---|---|
| | Check the covers in case of any damage or leakages | Fire/ sparks during wedge welding | 1. Dedicated fire fighting equipment to be taken along with (sand buckets/ fire extinguishers)<br>2. Training on the use of fire fighting equipment to be provided<br>3. PPE (Safety helmet , safety shoes (Gum boots), Cover all,respirator masks , safety gloves for waste direct dumping) to be provided |
| | | Spills -due to leaks | 1. Spill to be treated with spill control kit (fly ash, lime)<br>2. The waste to be handled and taken in a bag and disposed into the active spot<br>3. PPE (Safety helmet , safety shoes (Gum boots), Cover all, respirator masks for waste direct dumping) to be provided |

2. **Prevention Strategies:** The analysis underscores the importance of prevention in addressing hazards, which can be categorized as follows: Engineering Controls Implement exhaust ventilation systems to minimize airborne pollutants. Utilize machinery equipped with noise-reducing technology. Automate processes that pose high risks to decrease manual handling. Administrative Controls Establish and enforce clear standard operating procedures (SOPs). Provide ongoing training focused on hazard identification and appropriate responses. Rotate job tasks to alleviate the risk of repetitive strain injuries. Personal Protective Equipment (PPE) Equip workers with gloves, masks, safety goggles, hearing protection, and steel-toed footwear. Ensure that PPE is properly fitted and regularly inspected.

3. **Risk Matrix**

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| RISK MATRIX | | LIKELIHOOD | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| | | Insignificant | Minor | Significant | Major | Sever |
| SEVERITY | Insignificant | 1 | 2 | 3 | 4 | 5 |
| | Likely | 2 | 4 | 6 | 8 | 10 |
| | Modrate | 3 | 6 | 9 | 12 | 15 |
| | Major | 4 | 8 | 12 | 16 | 20 |
| | Critical | 5 | 10 | 15 | 20 | 25 |

By assessing the frequency and severity of a harmful event, the matrix technique in hazard valuation calculates the risk value.

This is how the risk rate is determined:

R is equal to P x S.

Where P is Probability

S is severity.

- **Measures for safety in Incineration**

1. Pushing waste manual

$$R = P \times S$$
$$= 6 \times 2$$
$$= 12$$

This risk should be signified.

2. Using caustic to the wet scrubber

$$R = P \times S$$
$$= 3 \times 2$$
$$= 6$$

This risk should be signified.

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- **Measures for safety in landfills**

1. Observation in the movement of landfill area

$$R = P \times S$$
$$= 3 \times 3$$
$$= 9$$

This risk should be signified.

2. Using excavators and dozers to leveling and compaction throughout the active site

$$R = P \times S$$
$$= 9 \times 2$$
$$= 18$$

This risk is severe.

**Recommendations for Comprehensive Risk Management**

**1. Hazard Identification:** Employ JSA to evaluate each job step and uncover associated risks.

**2. Regular Monitoring:** Continuously assess air quality, noise levels, and ergonomic conditions.

**3. Emergency Preparedness:** Organize drills for potential chemical spills, fires, or contamination incidents.

**4. Health Surveillance:** Conduct regular health assessments.

**5. Conclusion:** In the waste processing sector, health hazards present considerable risks to employees due to their exposure to toxic substances, the potential for physical injuries, and various environmental influences. A thorough evaluation based on Job Safety Analysis (JSA) is a vital instrument for identifying, assessing, and mitigating these dangers. By methodically examining each task, recognizing possible hazards, and applying suitable control measures, JSA promotes a proactive stance towards workplace safety. Implementing a JSA-based framework cultivates a safety-oriented culture, improves adherence to regulatory requirements, and decreases the frequency of work-related injuries and illnesses. Additionally, it supports ongoing enhancement by incorporating feedback, monitoring workplace conditions, and revising safety protocols as needed. By emphasizing the prevention of health hazards through JSA, organizations within the waste processing industry can protect their workforce, enhance operational efficiency, and foster a sustainable and responsible work environment. Ultimately, this strategy highlights the essential role of worker safety and well-being as a fundamental element of industry success.

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