Hazard Identification and Risk Assessment in Construction Industry

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Abstract:
In construction industries play a vital role in the world. Most of the products are heavy civil infrastructure. In most of the project workmen i.e. (welder, carpenter, fitter, plumber, helper, supervisor etc) play vital role in constructing infrastructure. In this project accident/incident is most important lagging factor for the project performances. How this accidents are happening at project sites. And what are the factors are affecting for the accident/incident, there are three major factor which affecting project safety performance i) human factor ii) physical condition iii)management factors and analysis the incident happened at multiple construction industries. This project found that the most significant accidents in the construction industry include fall from a height, fall from scaffoldings, and building collapse. Based on the study of past works of literature, the significant factors influencing construction accidents include technical causes, organizational causes, human causes, and environmental causes. The preventive measures taken by the construction industries are providing personal protective pieces of equipment (PPE’s), conducting toolbox meetings and safety training to the workers. The violation of OSHA guidelines should be recorded and reported. Workers must be aware of the hazards and safety programs to prevent construction accidents.

Keywords: construction industries, accident/incident, lagging factor, EHS performance, human factor, physical condition, management factors

1. INTRODUCTION

Development of safety for personnel in construction environment is recognized as a major factor for tranquility of staff and should be adhered precisely in accordance safety regulations. Despite the mechanization, the construction industry is still based on labor intensive, while working environments are often changing and include several different parties. The construction workers are one of the most vulnerable members in a project and are faced with a wide variety of hazards during their work. A common approach for prevention of construction accident is to predict the upcoming event under given circumstances. The accuracy of such predictions is based on knowledge about past accidents. It has been proved that the main reasons for accidents in the construction industry are resulted from the unique nature of the industry, human behavior, difficult work-site conditions, and poor safety management which result in unsafe work methods and procedures. The construction engineers and projects managers should be fully aware of hazards and prepared to deal with accidents when they occur. They should apply proper investigations and reporting procedures afterwards because the probability and severity of accidents in construction are higher in compare with other industries. From another aspect, accidents not only cause horrible human disasters but also create substantial economic losses. These financial losses are due to the impact of accidents and damages on plant equipment and workers. Moreover, there is also a loss of productive work time until the normal site working environment and morale return to the initial state. Hazard is defined as potential situation that may cause unintentional injuries or deaths to people, or damage to, or loss of an item or belongings. Therefore the estimation of the safety level at construction sites can be applied by specifying all on-site hazardous elements. Therefore, Safety performance of each element should then be studied and measured by evaluating the relevant on-site hazard factors. By reducing the potential hazard of elements, its safety performance improves. On the other hand, safety development in the construction industry occurs only when all workers in the operation of construction sites change their behavior, respect to regulations and try to improve safety level in their personal activities. Moreover, the management support to the workers is also very important in providing the best solution for the safety related problems. The main purpose of this paper is to identify main factors which contribute to safety development and provides a continuous approach to reduce risk and potential hazard of elements by six stages which will be discussed later. For the purpose of this study, at first the causes of accident are explained from literature. The second part describes the eight factors influencing safety performance level in construction project and finally an applicable approach is discussed to obtain safer workplace.

1.1 SAFETY PROCEDURE AS PER CODES AND STANDARDS

Management and planning is one way to avoid unplanned events. Since accidents are unplanned events, an effective safety management can help avoid job injuries. Safety management must be through, and it must be applicable to all aspects of the job, from the estimating phase of the project until the last worker has left the premise at the completion of the project. All parties to a construction project must be included in some way in the safety program every party is responsible. The construction industry continues to be one of the most physically demanding and dangerous industries in the India. The Construction activities in developing countries, such as Pakistan, China and India, are more labor intensive that in the developed areas of the globe, involving 2.5-10 times as many workers per activity. Typically workers tend to be unskilled and migrate in a group, with or without their families, throughout the country in search of employment. In fact, they are usually divided into various factions. Communication problems related to difference in language,
relation and culture tend to inhibit safety on the work site. Construction safety in India is still in its early years because safety laws are not strictly enforced. The contractors ignore basic safety rules and regulations. Although, to improve working conditions, the government has enacted specific legislation like the Minimum Wages Act, the Workmen’s Compensation Act of 1923 (modified in 1962), and the Contract Labor (Regulation and abolition) Act of 1970, very little of these are put into practice. National Building Code of India 2005 provides guidelines for regulating construction activities across the country NBC. Even then, workers’ safety in the Indian construction industry is frequently pushed to the bottom stage of priorities by builders, contractors, and engineers. In developing countries, safety rules usually do not exist, if exist; regulatory authorities are unable to implement such rules effectively. Therefore, effective safety knowledge among construction professionals can reduce accidents that directly or indirectly reduce project cost. Especially in developing countries like India, efforts should be made to raise the level of awareness among the workers and the employers about the importance of health and safety-related issues. Therefore, objective behind this paper was to create awareness among construction workers about the safety problems and injuries in the construction industry. The safety knowledge available on the subject has been categorized and discussed in subsequent sections.

2. PROBLEM IDENTIFICATION

The construction industry has been identified as one of the most hazardous industries in many parts of the world, as measured by work-related mortality, workers’ compensation, injury and fatality rates. Accident is the main issue to consider in any industries, construction industry is no exception. It is a high-risk industry that covers a wide range of activities involving construction, modification, and/or reparations. There are three major factors which affecting project EHS performance i) human factor ii) physical condition iii) management factors and analysis the incident happened at multiple construction industries. Due to the above risk in the construction sites the new method called risk management systems its work on the principle by converting log indicator to lead indicator techniques by the programmers like c++ and java by this technique we can prevent the human error and enhance the safety.

3. CAUSES OF ACCIDENTS IN CONSTRUCTION SITE

3.1 CAUSES OF ACCIDENTS

Nowadays statistics of accident in construction industry encourage researchers to find new way for improving or enhancing safety performance in construction industry. Furthermore, both of direct and indirect cost of accident adds more expenses to construction projects that are because of improper safety performance in construction site. Most of these accidents near 99 percent are caused because of unsafe act, unsafe condition or both. In order to improve safety performance in construction industry we require to identify the root causes of construction accident. This kind of equipment and machineries, site condition, nature of the industry, management attitude and method, and human elements can directly influence the safety performance in construction industry. Working at height, in adequate safety devices, poor management, lack of obedient on site, negligence of worker, and employing unskilled worker is so common in construction industry that cause to increase the risk of accident and making damage and injuries. The stated that the causes of accident are related to worker turnover and wrong act, lack of safety performance, unsuitable or unclean materials, no maintenance tool, and weak supervisory and inspection. On the other hand, we can divide the causes of accident to human and physical factors. Human factors are related to personal duty and responsibility such as neglect to use protective equipment, utilizing machines and equipment without permission, rushing in operating and doing work, personal factors, service moving and energized equipment, remove safety device, select unsafe position in working, utilizing improper equipment and other unsafe act. While, physical factors were addressed to wrong act of another person, unconsidered to accident source, disregard to special procedure, clothes hazard, environment hazard, fire hazard, wrong method or arrangement, assignment of personnel in wrong position, no safety guard in site and other unsafe condition, the cause if the accident in construction site is directly related to inadequate safety regulation, no force to use the regulation in site, no safety consideration by personnel on site, no encourage professional people to work in site, mechanical problem of construction machinery and equipment, and chemical or physical disturbance. We can exhibit the cause of accident according above statement in fishbone model.

3.2 MAJOR FACTOR FOR ACCIDENT

There are three major factors which affecting project EHS performance i) human factor ii) physical condition iii) Management factors and analysis the incident happened at multiple construction industries.

3.3 CAUSES OF ACCIDENT BY HUMAN FACTORS

According to accidents are caused due to poor safety awareness, lack of training, lack of organizational commitment, poor technical supervision, uncontrolled operation, unwillingness to input resources for safety, shortage of skilled labor, unsafe equipment, lack of first aid facilities, lack of safety regulations, lack of personal protective equipment, lack of innovative technology, and poor information system. Physical hazards are present in every construction project. These hazards include noise, heat and
cold, radiation, vibration and barometric pressure. Construction work often must be done in extreme heat or cold, in windy, rainy, or foggy weather or at night. Ionizing and non-ionizing radiation is encountered, as are extremes of barometric pressure. The machines that have transformed construction into an increasingly mechanized activity have also made it increasingly noisy. The sources of noise are engines of all kinds (e.g., on vehicles, air compressors and cranes), winches, rivet guns, nail guns, paint guns, pneumatic hammers, power saws, sanders, routers, planers, explosives and many more. Noise is present on demolition projects by the very activity of demolition.

It affects not only the person operating a noisemaking machine, but all those close-by and not only causes noise-induced hearing loss, but also masks other sounds that are important for communication and for safety. Pneumatic hammers, many hand tools and earth-moving and other large mobile machines also subject workers to segmental and whole-body vibration. Heat and cold hazards arise primarily because a large portion of construction work is conducted while exposed to the weather, the principal source of heat and cold hazards. Roofers are exposed to the sun, often with no protection, and often must heat pots of tar, thus receiving both heavy radiant and convective heat loads in addition to metabolic heat from physical labour. Heavy equipment operators may sit beside a hot engine and work in an enclosed cab with windows and without ventilation.

Those that work in an open cab with no roof have no protection from the sun. Workers in protective gear, such as that needed for removal of hazardous waste, may generate metabolic heat from hard physical labor and get little relief since they may be in an air-tight suit. A shortage of potable water or shade contributes to heat stress as well. Construction workers also work in especially cold conditions during the winter.

The principal sources of non-ionizing ultraviolet (UV) radiation are the sun and electric arc welding. Exposure to ionizing radiation is less common, but can occur with x-ray inspection of welds, for example, or it may occur with instruments such as flow meters that use radioactive isotopes. Lasers are becoming more common and may cause injury, especially to the eyes, if the beam is intercepted. Strains and sprains are among the most common injuries among construction workers. These, and many chronically disabling musculoskeletal disorders (such as tendinitis, carpal tunnel syndrome and low-back pain) occur as a result of either traumatic injury, repetitive forceful movements, awkward postures or overexertion. Falls due to unstable footing, unguarded holes and slips off scaffolding and ladders are very common.

3.3.1 Carelessness of the Workers

In this case, both the workers and the supervisor might be convinced that the risk is low. It’s human nature to assess risk based on experience, so each time you take a risk and don’t get injured, it reinforces the idea that the task was safe or the risk was too low to matter. Young workers, such as apprentices, may be prone to take more risks to prove they are good workers or they may be less likely to speak up about hazards. Because of these factors, young workers tend to have higher injury rates. The challenge for safety professionals is convincing people to take precautions for risks they may never encounter, but are nonetheless very real dangers.

3.3.2 Persons Fall Due To Poor Concentration

The poor concentration in construction site is very impact for human. The Centers for Disease Control and Prevention states that falls can happen in all occupational settings, and “circumstances associated with fall incidents in the work environment frequently involve slippery, cluttered or unstable walking/working surfaces; unprotected edges; floor holes and wall openings; unsafe positioned ladders; and misused fall protection.
“To reduce the risk of falling at work, CCOHS recommends paying attention to your surroundings and walking at a pace that’s suitable for the surface you’re on and the task you’re performing. Additionally, walk with your feet pointed slightly outward, make wide turns when walking around corners and use the handrails on stairs.

3.3.3 Ignorance of PPE

In the safety world hazard recognition plays a vital role in keeping your people safe from unsafe behaviors and/or conditions. Some hazards are easily recognized, for example an employee climbing up a 20 foot ladder with tools held in both hands. At a minimum, each employee is required to wear a hard hat and safety glasses. High visibility safety vests with reflective striping are required when employees are exposed to vehicular traffic.

3.3.4 Failure to Follow Safety Rules

Failures by employers or contractors to follow state and federal safety regulations too often result in death or injury to workers, or even to worksite visitors or passersby.

3.3.5 Falls from High Heights or Scaffolding

Fall hazards are present at most worksites and many workers are exposed to these hazards on a daily basis. A fall hazard is anything at your worksite that could cause you to lose your balance or lose bodily support and result in a fall. Any walking or working surface can be a potential fall hazard. Any time you are working at a height of four feet or more, you are at risk. OSHA generally requires that fall protection be provided at four feet in general industry, five feet in maritime and six feet in construction. However, regardless of the fall distance, fall protection must be provided when working over dangerous equipment and machinery. The importance of fall protection cannot be stressed enough. Fall hazard incidents are injuries produced by impact between the injured person and the source of injury when the motion producing contact was generated by gravity. Fall hazards in construction cause accidents such as the following: A makeshift scaffold collapsed under the weight of four workers and their equipment, seriously injuring all four. A worker carrying a sheet of plywood on a flat roof stepped into a skylight opening and fell to the level below. A roofer, while attempting to remove a roof opening cover, fell approximately 21 feet to the concrete floor below and was killed. A construction worker was working from a carpenters’ wall bracket scaffold without fall protection. The worker fell 19 feet to the ground, sustained blunt trauma to the head and later died. Construction workers are often required to work at veryhigh heights, on scaffolding and ladders, in windows and on roofs. A fall is categorized when a person is injured after falling or jumping from a ladder, scaffold, building, roof, or other elevated place or working area landing, with impact, on the ground or surface below. According to the Bureau of Labor Statistics, these accidents account for 34 percent of all on-the-job deaths of construction workers.

Causes
• Unprotected roof edges, roof and floor openings, structural steel and leading edges, etc.
• Improper scaffold construction
• Unsafe portable ladders
• A safe system of work for scaffold dismantling was not provided
• The tubular scaffold was not horizontally and securely erected on the inclined floor
• The worker overstretched his body from the working platform resulting in the imbalance of the tubular scaffold
• The steel plate underneath the tubular scaffold failed to balance and secure the scaffold
• The overall structure of the boatswain’s chair was unsafe
• The whole structure was not inspected by a competent examiner before use
• The fall arrestor and independent lifeline were not properly installed, thus failing to prevent the worker from falling

3.3.6 Slips, Trip and Falls

From stray tools and materials to uneven ground or holes, there are many hazards on a construction site that could lead to a dangerous slip, trip, or fall. Slips happen when there isn’t enough friction or traction between your feet and the surface you’re walking on. Common causes of slips include wet or oily floors, spills, loose or unanchored mats, and flooring that lacks the same degree of traction in all areas, CCOHS states. Trips happen when your foot strikes an object, causing you to lose your balance. Workers trip due to a variety of reasons, including clutter in walkways, poor lighting, uncovered cables, drawers being left open and wrinkled carpeting or rugs. To help prevent slips and trips, CCOHS recommends the following:
• Clean up spills immediately. If a spill can’t be cleaned up right away, place “wet floor” warning signs for workers.
• Keeps walkways and hallways free of debris, clutter and obstacles.
• Keep filing cabinets and desk drawers shut when not in use.
• Cover cables or cords in walkways.
• Replace burnt-out light bulbs promptly.
• Consider installing abrasive floor mats or replacing worn flooring.
• Encourage workers to wear comfortable, properly fitted shoes.

IJESC, June 2021

28208

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Causes
• spills of liquid or solid material
• wind-driven rain or snow through doorways
• change from wet to dry surface
• dusty and sandy surfaces
• the incline of a ramp low light levels
• use of unsuitable footwear, with wet, muddy, greasy or oily soles
• Wet or greasy floors, Loose flooring, carpeting or mats
• Uneven walking surfaces
• Missing or uneven floor tiles and bricks
• Damaged or irregular steps; no handrails
• Electrical cords or cables
• Ramps and gang planks without skid-resistant surfaces
• Metal surfaces – dock plates, construction plates

3.3.7Electrocutions
Due to the fact that construction sites are a work in progress, there is often exposed wiring, power lines, and unfinished electrical systems around. Coming in contact with these could lead to electrocution or shock. In many of the electrocutions, electrical workers and other construction workers touched metal objects that had become energized through contact with live electrical equipment and wiring or with overhead power lines. Thus, 42 (12%) of the electrocutions of electrical workers and 88 (32%) of those of other construction workers that involved electrical wiring and equipment involved these contacts. The most common contacts were with metal ladders, metal pipes, metal wires that were deliberately cut or stripped or were accidentally cut by electric drills or other tools, wires that were energized by contact with live wires, and energized trucks and other vehicles. Electrocutions as a result of metal objects contacting overhead power lines involved 26 electrical workers and 167 of other construction workers. The most common examples involved metal ladders, cranes, aerial lifts, trucks or heavy equipment (such as water well drillers, backhoes, concrete pumpers and dump trucks), wires, metal poles, and metal scaffolds or scaffold parts. Working in cramped areas was a contributing factor in 97 electrocutions (6%), about 8 deaths per year. For electricians, working in attics or above drop ceilings was a risk and for other construction workers, working under houses, in basement crawlspaces, or in attics. Standing in water or having equipment such as trouble lights and extension cords touching water was a contributing factor in at least 51 electrocutions. Low voltage (600 volts and under) was involved in the electrocutions of at least one-third of electrical workers and one-quarter of non-electrical workers. At least 14% of all electrocutions involved 120/220 volts (household current). (The voltage was not known in more than one-quarter of electrocutions.)

• Electrocution when Using Hand Tool
• Electrocution when Carrying Out Electrical Works

Causes
• The workplace was damp and with water pools
• The electric saw was not properly earthed
• The power socket was not fitted with any residual current device (commonly known as earth leakage circuit breaker)
• There was leakage current from the electric saw
• The power supply had not been disconnected before the works were carried out
• The insulations of some of the wires had been damaged
Injuries type Shock, Burns, Falls due to contact with electricity, Electrocution (death)

3.3.8Struck By Object
Struck-by injuries are produced by forcible contact or impact between the injured person and an object or piece of equipment. Having said that, it is important to point out that in construction, struck-by hazards can resemble caught-in or – between hazards.

• Struck-by flying object
• Struck-by falling object
• Struck-by swinging object
• Struck-by rolling object

Causes
• The catastrophic failure of equipment on the oil rig
• Objects falling off the rig’s superstructure, the tops of tanks, building roofs, scaffolding, aerial lifts, cranes and fork lifts can strike employees working nearby
• tripping pipe in and out, the derrick man or the floor hands
• Semi-tractor trailers, crew trucks, service vehicles, end loaders, excavators and fork lifts can pose

3.3.9Falling Debris, Materials or Objects
A construction worker injured by falling debris, materials, or objects at a construction site should call an experienced personal injury lawyer for a free consultation. When mandatory construction site safety rules are followed such “accidents” do not generally happen. On construction sites, objects do not fall from the sky absent negligence.

On projects with multiple levels, it is common for falling tools, building materials, or beams to strike workers below.
• A metal bar falling from height
• Bricks falling from height
• Metal pipes falling during lifting operation
• Formwork panels being knocked over
• Toppling over of precast concrete building unit

Causes
• The metal bar was liable to fall as it was placed at the window edge on an upper floor
• The falling of the metal bar might be inadvertently caused by someone at work
• No secure fenders/bracings had been installed at the external wall of the building near the podium
• The concrete bricks were neither properly stacked nor securely tied
• The platform of the hoist was not installed with any enclosures to prevent loose materials from falling during lifting
• The frame of the hoist was unfenced

IJESC, June 2021 28209 http://ijesc.org/
• The metal pipes were not properly tied before lifting
• The materials were lifted past an area where workers were working
• The lifting operation was carried out despite insufficient communication between the crane operator and signaler
• The vertically placed panels lacked sufficient support and proper storage to prevent them from toppling over by accident.

3.3.10 Getting Caught In-Between Objects or Materials

According to OSHA, caught-in hazards collectively are one of the four deadliest dangers found on a construction site. Although it seems like common sense to never place yourself between a piece of heavy equipment and an immovable object, when you’re concentrating on the job at hand sometimes you find yourself in unexpected danger. Here are some tips to prevent becoming a victim of caught-in/between accidents.

Construction sites are filled with heavy machinery, tools, and materials. Often, workers find themselves stuck in between immovable objects, machinery, or fallen debris.

• Trapped During Lift Maintenance
• Caught between a vehicle and another object,
• Pinched between equipment and the rig’s substructure, and
• Crushed between a load of pipe that fell off a trailer and forklift.

Causes
• The stopping switch in the machine room as well as the emergency stop switch and the maintenance switch on the maintenance work
• No warning sign was posted to warn other people not to use the lift
• work involving moving equipment
• inadequate training or preparation
• completing a task under physical or mental pressure
• being absent-minded
• working with unreliable machinery

3.3.11 Fires and Explosions

Because of unfinished piping, leaking gases, and incomplete electrical systems, fires and explosions are a common occurrence on construction sites. Data from the Occupational Health & Safety Administration (OSHA) indicate that there are on average 36 fire and explosion deaths per year in the construction industry. From underground gas lines to temporary heating devices to electrical systems, construction sites in South Carolina are full of hazards that can turn a day’s work from routine to explosive in an instant.

Causes
• The use of flammable liquids
• Welding or abrasive cutting techniques used in places not specially prepared for such works
• Liquid gases used with an open flame;
• Flammable and combustible materials (e.g. petroleum, timber and packaging).
• Gas leaks;
• Chemical leaks;
• Electric sparks/malfunction;
• Welding;
• Static electricity;
• Combustible dust;
• Lack of training/negligence;

3.3.12 Overexertion

Hours of hard labor, often in extremely hot or humid conditions, can cause workers to overexert themselves and even fall victim to heat stroke accidents. The condition can lead to dehydration, exhaustion and reduced mental clarity. Simple mistakes can lead to devastating accidents that can quickly end the lives of one or more individuals. Overexertion is a major cause of construction accidents, and is possibly involved in far more accidents than has been reported. Recognizing and handling overexertion when it occurs is extremely important to avoiding serious accidents. Some of the signs of overexertion include fatigue, dizziness, significant sweating, chest pain, weakness, and sore muscles, tightening of muscles, a burning sensation, nausea and excessive thirst.

Overexertion is the No. 1 cause of non-fatal injuries according to a study carried out by The Center for Construction Research and Training overexertion creates stress on the joints and muscles in the body. Other ways overexertion injuries happen is because of repeated bending at Take the time to position your body correctly before you lift or move anything. It only takes a few seconds to position yourself correctly in order to prevent an overexertion injury form occurring. Bend at the knees when lifting. These will reduce the strain that is put on you back when lifting heavy objects. The waist and poor posture. These strains happen and can result in stretched or torn muscles. Construction workers are very susceptible to this type of overexertion, especially when they work outside on days that are hot and humid. Overexertion can be avoided, by taking breaks, staying hydrated, and using proper lifting and other techniques to reduce body stress.

Causes
• Reaching over the worker’s head;
• Working in small spaces;
• Reaching and leaning to pick up objects;
• Shovelling dirt, rocks, or other materials; and
• Bending over to grasp objects.

Overexertion occurs when the load, whether lifted, carried, pushed, pulled or otherwise handled, exceeds the limits of the human joint system doing the work.

3.3.12 Machinery accidents

Construction workers use a lot of heavy machinery in their work. From cranes and bulldozers to jackhammers and nail guns, an error or accident with these tools can be very dangerous. Making a single mistake while operating construction machinery can result in a very serious injury or even death. Some of the worst construction accidents are caused by heavy machinery malfunctions. The most catastrophic construction accidents involving machinery often result in life changing injuries such as amputations, traumatic brain injuries and even death. Surviving family members who’ve lost a loved one due to a machinery accident at a construction site may be able file a wrongful death lawsuit against whoever was responsible for making sure this type of accident does not occur. Construction equipment and machinery is often to blame for construction worker accidents. Actually, not the equipment itself, but those who designed it, maintained it, or used it improperly. Forklifts accidents, backhoe accidents, scissor lift accidents, masonry machinery accidents, hydraulic jack accidents, crane accidents, front-end loader accidents, boom accidents --- all these and many more construction machines and equipment cause innumerable accidents and injuries every year in New York and elsewhere.
But almost all circumstances, these accidents are not just “accidental”. They are caused by someone’s negligence or carelessness. Construction machinery and equipment is safe only when (1) it is designed and manufactured safely; (2) the workers who use the construction equipment and machinery are properly trained and supervised; (3) the workers who use the construction equipment and machinery do so safely and properly; (4) the construction equipment and machinery is properly maintained; and (5) the construction equipment and machinery is equipped with proper warnings.

**Causes**

- Accidents and injuries caused by faulty or unsafe work equipment.
- Falls from height due to defective or unsuitable ladders, working platforms or scaffolding.
- Injuries caused by sharp edges or broken parts on work equipment.
- Injuries sustained whilst using work equipment without proper protection.
- Work accidents and injuries caused by lack of proper training to use work equipment.
- Injuries caused by the unsafe use of work equipment.
- Workplace injuries caused as a result of unsuitable work equipment.
- Injuries type Amputations, traumatic brain injuries, hand and bone fracture.

**3.3.14 Trench Collapses**

Trenches are often a necessity on construction sites. If a trench collapses while a worker is inside, it could cause them to be hit with tools, machinery, or materials or bury them in the surrounding dirt. Trenches have been used and formed by people for hundreds of years for many different purposes including, agricultural uses, and installing utilities and pipelines. The construction of trenches is not simply digging in the soil, as it comes with risks and hazards. Some of the feared dangers associated with Trench construction are the trench collapses, cave-ins and side wall collapses. There are also some invisible dangers of trench contractions are asphyxiation inhalation of toxic fumes and suffocation. Out of these risks, trench collapse is the frequently happened incident on construction sites. If a Trench collapse happens unfortunately it does cause a lot of injuries to the workers digging the trench. Such injuries include broken leg or arm, death due to lack of oxygen when weight of collapses trench is on the buried worker leaving very little or no space for the proper supply of oxygen. Construction workers working on trenches face high risk of Trench collapse dangers and there are many reasons contribution in Trench collapses. Some of the commonly recognized reasons are that trench walls are not supported by shoring or trench boxes, trenches dig on previously disturbed soil, vibration of the land around the trench area due to the vehicles running too close to the trench, unsafe distance between spoil pile and the lip of the trench, dried trench walls that make trenches weak and heavy rain falls. Occupational Safety and Health Administration (OSHA) has many rules to minimize the Trench collapses and risks associated with it. For example as per OSHA regulations trenches deeper than five feet must be shored for support; this is because of the fact that most of the Trench collapses happen in trenches less than 12 feet deep. While most employers hesitate to use supportive trench boxes due to the added cost and put the lives of labors at higher trench collapse risks. Trench collapse incidents should not be taken lightly but there should be effective trench collapse preventive measures.

Trench collapse risks can be minimized by shifting the soil weight away from the trench opening. Trench collapses can also be minimized by placing trench sheets on both sides of the trench. The party responsible for carrying out construction work for trenches should carefully examine the soil conditions should employ a person qualified in trench safety to carry out tests to ensure there are no poisonous gases inside the soil prepared for trenches. The responsibility to reduce risks associated with trench collapses lies on the shoulders of both employer and workers. It is wise if both undertake necessary training on trenches collapse before executing work for the construction of trenches.

**Causes**

- Moving machinery near the edge of a job site excavation can cause a collapse of a wall within the excavation.
- A rainstorm or flooding from a broken water main could increase the risk for injury.
- Improper shoring or bracing can cause catastrophic injury to workers.
- Contact or sever underground utility lines.
- Flooding:
  - Improper shoring;
  - Equipment defects;
  - Machinery resting dangerously close to the trench;
  - Inadequate safety equipment; and
  - Poor digging.

**3.4 CAUSES OF ACCIDENT BY PHYSICAL CONDITION**

**3.4.1 Light (LHT)**

Light linked to visibility related accident in workplace. In some occasion, insufficient lighting and blind spots can cause accidents. Sometimes glare reflected from equipment and tool can disrupt visibility in a person field of vision causing run over accidents.

**3.4.2 Weather (WTH)**

Working environment and variety of natural phenomenon can cause fatalities on site, as most of these are unpredictable. This includes rain, wind, earthquake, flooding and landslides.

**3.4.3 Sunlight (SUN)**

Working under direct sunlight for a long period of time may cause heat rashes, heat exhaustion, and heat stroke. This could lead to a more serious health-related issues, and accident.

**3.4.4 Ventilation (VEN)**

Working in an enclosed space with no ventilation making it hard to breathe.

**3.4.5 Dust (DUS)**

Dust that builds up when cutting, drilling or grinding material on the construction site can cause serious effects inside the body if exposed to for a long period of time.

**3.4.6 Noise (NOS)**

Frequent exposure to high level of noises either from the environment or from equipment can cause hearing damage.

**3.4.7 Layout (LAY)**

Inadequate space or difficult entry to perform a certain tasks was recognized as 15% of the accident studied therefore leading this to one of the major case whereby the delivery vehicle partially overturned due to the lack of sufficient room to extend the stabilizers.
3.4.8 Electrical hazard (ELC)
Electrical hazard causes 44% of all fatal electrical accidents from all industry. Mismanagement and poor protection of electrical system leads to fatalities.

3.4.9 Vibration (VIB)
Working with operating machine or equipment that vibrates at a high frequency could cause workers to become exhausted and stagnant.

3.5 CAUSES OF ACCIDENT BY MANAGEMENT FACTORS

3.5.1 Equipment design (DSG)
Appropriate tools design can eliminate common safety hazard.

3.5.2 Quality of material (QLT)
Collapsing of building can be caused by poor material quality. Ransom et al., stated that poor quality of material causes accidents in construction industry.

3.5.3 Innovative technology (TEC)
Outdate equipment could cause ineffective work and injuries, as it cannot provide a suitable function for some specific.

3.5.4 Sub-contractor’s equipment (SUB)
Subcontractor provides equipment machine and their employees to the construction company under the agreement to help them finish the project on time. Improper use of subcontractor’s equipment could lead to construction accident.

3.5.5 Safety related budget (BUD)
Construction Company should provide enough budgets to support necessary safety-related activities.

3.5.6 Project duration (DUR)
In limited project time available, workers are force to work under pressure. This in turn, causes accidents.

3.5.7 Customer satisfaction (PSR)
When Construction Company tries to meet the expectations of customer so as to satisfy them, pressure builds up leading to unexpected accidents, which should not happen.

3.5.8 Maintenance program (MTN)
According Ransom et al., tools and equipment in the construction site are not properly maintained. This could lead to serious accidents.

3.5.9 Safety training program (TRN)
The training program that does not match the nature of work, is meaningless.

3.5.10 Adequate provision of safety equipment (ADQ)
Many construction companies in Thailand do not have enough PPE to provide to all of their employees when they come to work, therefore some worker needs to buy the PPE for themselves. PPE are also expensive and this leads to worker not buying it as they could not afford the safety equipment.

3.5.11 Work hours (SHF)
Accidents in the accidents in the construction site occur when workers work more than eight hours per day or 60 hours per week.

3.6 RANKING AND MEAN VALUE OF CAUSES OF ACCIDENTS

Table 3.1 Ranking and Mean Value of Causes of Accidents

<table>
<thead>
<tr>
<th>Causes of Accidents</th>
<th>Mean Value</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failure to follow safety rules</td>
<td>4.3213</td>
<td>1</td>
</tr>
<tr>
<td>Ignorance of PPE</td>
<td>4.0365</td>
<td>2</td>
</tr>
<tr>
<td>Space congestion</td>
<td>3.6277</td>
<td>3</td>
</tr>
<tr>
<td>Improper use of safety items</td>
<td>3.5182</td>
<td>4</td>
</tr>
<tr>
<td>Improper equipment</td>
<td>3.2993</td>
<td>5</td>
</tr>
<tr>
<td>Lack of proper training</td>
<td>3.2701</td>
<td>6</td>
</tr>
<tr>
<td>Inadequate Construction Planning</td>
<td>3.2628</td>
<td>7</td>
</tr>
<tr>
<td>Inexperienced</td>
<td>3.2117</td>
<td>8</td>
</tr>
<tr>
<td>Faulty Ladders/ Scaffoldings</td>
<td>3.1095</td>
<td>9</td>
</tr>
<tr>
<td>Poor line of communication among safety officer and employees</td>
<td>2.9635</td>
<td>10</td>
</tr>
<tr>
<td>Due to substance Abuse</td>
<td>2.7737</td>
<td>11</td>
</tr>
<tr>
<td>Lack of Coordination</td>
<td>2.6715</td>
<td>12</td>
</tr>
<tr>
<td>Persons fall due to poor concentration</td>
<td>2.4015</td>
<td>13</td>
</tr>
<tr>
<td>Dropping/ throwing objects from high rise projects</td>
<td>2.3723</td>
<td>14</td>
</tr>
<tr>
<td>Improper stacking</td>
<td>2.1022</td>
<td>15</td>
</tr>
<tr>
<td>Mental illness</td>
<td>2.0657</td>
<td>16</td>
</tr>
<tr>
<td>During unloading of goods</td>
<td>2.0365</td>
<td>17</td>
</tr>
<tr>
<td>Improper housekeeping</td>
<td>2.0146</td>
<td>18</td>
</tr>
<tr>
<td>Carelessness</td>
<td>1.9781</td>
<td>19</td>
</tr>
<tr>
<td>Harsh Deadlines</td>
<td>1.9635</td>
<td>20</td>
</tr>
<tr>
<td>Due to structural failure</td>
<td>1.9562</td>
<td>21</td>
</tr>
<tr>
<td>Improper signaling</td>
<td>1.9562</td>
<td>21</td>
</tr>
<tr>
<td>Less concentration of workers or drivers</td>
<td>1.9343</td>
<td>22</td>
</tr>
<tr>
<td>Rash driving</td>
<td>1.8175</td>
<td>23</td>
</tr>
<tr>
<td>Improper positioning and posture during working</td>
<td>1.8102</td>
<td>24</td>
</tr>
<tr>
<td>Unclear of the information</td>
<td>1.7883</td>
<td>25</td>
</tr>
<tr>
<td>Language barrier (speaking, writing and reading)</td>
<td>1.7518</td>
<td>26</td>
</tr>
<tr>
<td>Material component failure</td>
<td>1.7518</td>
<td>26</td>
</tr>
<tr>
<td>Welding accidents</td>
<td>1.7445</td>
<td>27</td>
</tr>
<tr>
<td>Poor understanding of signage (safety information and warning signs)</td>
<td>1.7374</td>
<td>28</td>
</tr>
<tr>
<td>Due to landslides</td>
<td>1.6161</td>
<td>29</td>
</tr>
<tr>
<td>Incompetence</td>
<td>1.6058</td>
<td>30</td>
</tr>
<tr>
<td>Problems occur during grounding</td>
<td>1.5912</td>
<td>31</td>
</tr>
<tr>
<td>Struck by moving vehicles</td>
<td>1.5839</td>
<td>32</td>
</tr>
<tr>
<td>Struck by sharp things</td>
<td>1.5766</td>
<td>33</td>
</tr>
<tr>
<td>Improper walkway/ roadway</td>
<td>1.5766</td>
<td>33</td>
</tr>
<tr>
<td>Due to compressed gas explosion</td>
<td>1.5766</td>
<td>33</td>
</tr>
<tr>
<td>Inflammable materials unsecured</td>
<td>1.5766</td>
<td>33</td>
</tr>
<tr>
<td>Poor judgment</td>
<td>1.5693</td>
<td>34</td>
</tr>
<tr>
<td>Forms of message transferred cause confusion</td>
<td>1.5693</td>
<td>34</td>
</tr>
<tr>
<td>No proper traffic control</td>
<td>1.5474</td>
<td>35</td>
</tr>
<tr>
<td>Fall of building or a part of it</td>
<td>1.4380</td>
<td>36</td>
</tr>
<tr>
<td>Accident due to elevator shaft falls</td>
<td>1.2920</td>
<td>37</td>
</tr>
<tr>
<td>Due to crane falls</td>
<td>1.2117</td>
<td>38</td>
</tr>
</tbody>
</table>

4. EFFECTS OF ACCIDENTS IN CONSTRUCTION SITE
As the construction industry is carried out in hazardous environments, it experiences accidents in different levels of severity, some causing minor and major.
Injuries with even some resulting in fatality.

Table 4.1 Ranking and Mean Value of Effects of Accident

<table>
<thead>
<tr>
<th>Effects of Accident</th>
<th>Mean Value</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of Medical Expenses</td>
<td>4.3577</td>
<td>1</td>
</tr>
<tr>
<td>Time loss of project execution</td>
<td>3.7299</td>
<td>2</td>
</tr>
<tr>
<td>Productivity Loss</td>
<td>3.4453</td>
<td>3</td>
</tr>
<tr>
<td>Distrust of Firm</td>
<td>3.1898</td>
<td>4</td>
</tr>
<tr>
<td>Cost of training given tone worker</td>
<td>3.1460</td>
<td>5</td>
</tr>
<tr>
<td>Cost of Recruiting networker</td>
<td>3.0219</td>
<td>6</td>
</tr>
<tr>
<td>Mental illness of workers</td>
<td>2.8832</td>
<td>7</td>
</tr>
<tr>
<td>Cost of Accident investigation time</td>
<td>2.5401</td>
<td>8</td>
</tr>
<tr>
<td>Additional supervision cost</td>
<td>2.1314</td>
<td>9</td>
</tr>
<tr>
<td>Compensation Cost</td>
<td>1.9343</td>
<td>10</td>
</tr>
<tr>
<td>Repairs</td>
<td>1.9124</td>
<td>11</td>
</tr>
</tbody>
</table>

5. EHS RISK MANAGEMENT

Heavy Civil Infrastructure moves towards a zero harm vision through the L.I.F.E. program there requires a management game changing shift and a complete gradual overhaul of what was done in the past so as to meet the current business model. EHS Risk Management is an integral part of the IMS and combines technical, consultative, systematic and managerial approaches to identify any foreseeable hazards that have the potential to harm employees, partners, contractors, visitors and members of the public.

5.1 SCOPE
- This procedure is applicable for all offices, project sites and operations globally. EHS Risk Management shall cover:
  - All routine and non-routine activities
  - Activities of all personnel having access to the workplace (including contractors, visitors)
  - Facilities at the workplace (eg. office, canteen, workmen facilities etc)

5.2 PURPOSE
- Risk management process is applied through the five steps to risk management and is the key driver for risk control in business:
  - All relevant parties including construction & EHS teams must be involved in risk assessments and the risk management process;
  - Risk assessments & Safe Work Method statement must be developed and approved prior to any work activity starting;
  - All Identified risks and risk mitigation plans must be documented, approved and simply communicated to all parties.

Class 1 Risk Activities
The activities carried out within the IC that has the potential to cause fatal, serious injury within the business.

Environmental Impact
Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization's environmental aspects.

Hazard
Source, situation, or act with a potential for harm in terms of human injury or ill health or a combination of these.

Risk
Combination of the likelihood of an occurrence of a hazardous event or exposure(s) and the severity of injury or ill health that can be caused by the event or exposure(s).

Risk Assessment
Process of evaluating the risk(s) arising from a hazard(s), taking into account the adequacy of any existing controls, and deciding whether or not the risk(s) is acceptable.

Risk Review
It is the periodic review of Corporate & Project EHS Risk Registers and Activity specific EHS Risk assessments. Risk control measures that have been implemented and are still effective in

Existing Control
Controlling the Hazard.

Risk Management (RM)
The identification, assessment and prioritization of Workplace Environment, Health and Safety risks followed by the application of control measures to minimize the probability and/or impact of undesirable EHS consequences.

5.3 RESPONSIBILITIES

Table 5.1 Responsibilities

<table>
<thead>
<tr>
<th>IC Head</th>
<th>IC Head shall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Approve the Corporate EHS Risk Register.</td>
</tr>
<tr>
<td></td>
<td>• Review Corporate EHS Risk Register and approve the necessary changes once in 6 months.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>IC EHS Head</th>
<th>IC EHS Head shall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Review the Corporate EHS Risk Register and maintain up-to date. Review it once in 6 months.</td>
</tr>
<tr>
<td></td>
<td>• Exercise STOP WORK Authority when any unsafe practices condition observed.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cluster EHS Head</th>
<th>Cluster EHS Head shall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Participate in the Corporate EHS Risk Review when requested</td>
</tr>
<tr>
<td></td>
<td>• Participate in Risk Assessments and assume role of mentor</td>
</tr>
<tr>
<td></td>
<td>• Exercise STOP WORK Authority when any unsafe practices / condition observed.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project Head</th>
<th>Project Head is the owner for the EHS Risk Management at project. Project Head shall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Chair the EHS Risk Management Workshops</td>
</tr>
<tr>
<td></td>
<td>• Appoint Risk Assessment Leader and Risk Assessment team for carrying out the Project</td>
</tr>
<tr>
<td></td>
<td>• EHS Risk review and prepare Project EHS Risk Register</td>
</tr>
<tr>
<td></td>
<td>• Oversee the Risk Assessment activity</td>
</tr>
<tr>
<td></td>
<td>• Approve the Project EHS Risk Register, Activity EHS Risk Assessment and SWM.</td>
</tr>
</tbody>
</table>

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28213

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• Order the Risk assessment team to conduct periodic EHS Risk review every month.
• Exercise STOP WORK Authority when any unsafe practices / condition observed.

**Project EHS In charge**

- Project EHS In charge shall
- Co-ordinate the EHS Risk Management Workshops
- Establish the Risk Management procedure at project site
- Ensure Risk Assessment team is competent and trained to carry out Risk Assessments.
- Prepare the Project EHS Risk Register and maintain up-to date
- Participate in the Project EHS Risk Reviews and activity risk assessments and assume the role of mentor.
- Schedule and carry out periodical inspections and audits to assess the implementation of SWM and also to check the adequacy of Risk Assessment and advice of improvement where necessary.
- Keep the Risk Management Register up-to date in IM 12 C
- Facilitate implementation of work permit system as per IM 14 permit work.
- Exercise STOP WORK Authority when any unsafe practices / condition observed.

**Section Incharge / Engineer In charge**

- Engineer In-charge is responsible for implementing the Safe Work Method statement.
- Engineer In-charge shall
  - Participate in the EHS Risk Management Workshops
  - Participate in the EHS Risk Assessment exercise for the activity he/she carries out.
  - Prepare the SWM for all activities based on EHS Risk Assessment and submit the SWMfor review and approval
  - Prepare briefing sheets in consultation with Project EHS Engineer
  - Carry out activities / task as per approved SWM only.
  - Carry out regular inspection with respect to SWM to verify implementation.
  - Implement the work permit system as per IM 14
  - Exercise STOP WORK Authority when any unsafe practices / condition observed.

**EHS Risk Assessment Team**

- The risk assessment team shall comprise of Engineer In charge, Project EHS In charge and relevant service function involved in activity like P&M, Formwork, Mechanical Engineer, Partner representative/subcontractor, supervisor, technician/skilled workmen.
- The risk assessment team shall readily actively participate in the Risk Assessment exercise

**EHS Risk Assessment Team Leader**

- A person competent in the activity to be risk assessed and trained in Risk Assessment technique shall be appointed as EHS Risk Assessment team Leader.
- Exercise STOP WORK Authority when any unsafe practices / condition observed.

**Employees**

- Shall readily participate in the risk assessment process, as and when invited.
- Adhere to the SWM.
- Exercise STOP WORK Authority when any unsafe practices / condition observed.

**Contractors**

- Participate in the EHS Risk Management Workshops
- When requested produce Risk Assessment & SWM for approval before commencing the activity or they shall adhere to the SWM issued by team.
- Shall readily participate in the risk assessment process, as and when invited.
- Exercise STOP WORK Authority when any unsafe practices / condition observed.

---

5.4 METHOD

5.4.1 Risk Management Flowchart
5.4.2 Risk Assessment & Risk Reviews at various levels

All the activities under the project scope shall be covered in the process and it shall be recorded in IM 12 A EHS Risk Register / Risk Assessment.

- EHS Risk Assessments and periodic Risk Reviews shall be conducted at Corporate, and Project levels to identify all the Class 1 risk activities within the operations and take appropriate control measures to mitigate the risk.

<table>
<thead>
<tr>
<th>S.No</th>
<th>Activity</th>
<th>Corporate EHS Risk Register</th>
<th>Project EHS Risk Register</th>
<th>Activity EHS Risk Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Who leads the EHS Risk review?</td>
<td>IC EHS Head</td>
<td>Cluster EHS Head or Project EHS In charge</td>
<td>Engineer In charge</td>
</tr>
<tr>
<td>2</td>
<td>What is the timeline?</td>
<td>30 days from launch of procedure</td>
<td>30 days from start of project</td>
<td>7 days before commencement of work</td>
</tr>
</tbody>
</table>

5.4.3 Steps EHS Risk Management process

5.4.3.1 Identify Hazards / Aspects

The first step involves the identification of hazards / environment aspects associated with the activity. The following points shall be taken into account while identifying the health & safety hazards and environmental aspects:

- activities of all persons having access to the workplace;
- human behaviour, capabilities and other human factors;
- hazards originating outside the workplace capable of adversely affecting the health and safety of persons under the control of the organization within the workplace;
- hazards / aspects created in the vicinity of the workplace by work-related activities under the control of the organization;
- infrastructure, equipment and materials at the workplace, whether provided by the organization or others;
- changes or proposed changes in the organization, its activities, or materials;
- modifications to the EHS management system, including temporary changes, and their impacts on operations, processes, and activities;

- The design of work areas, processes, installations, machinery/equipment, operating procedures and work organization, including their adaptation to human capabilities

During this process, identify the particular hazard or aspect (source / situation / act) and ascertain the possible outcome and people at risk.

5.4.3.2 Evaluate the risk / impact

The risk evaluation shall be done by:

- Identifying the existing risk control measures;
- Determining the likelihood of occurrence (probability);
- Assessing the potential severity of the health & safety hazards, environmental aspects;
- Ascertaining the risk / impact level based on the likelihood and severity

Existing Risk Control

- The presence of existing control measures shall be first identified for each of the Health & Safety hazard, Environment aspect.
- By considering the effectiveness of the existing controls and the consequences of their failure, the risk / impact level can be assessed.

Likelihood of occurrence (Probability)

Likelihood of occurrence of an incident is classified as per the table given below.

<table>
<thead>
<tr>
<th>Probability Descriptions</th>
<th>VALUE</th>
<th>Status</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Likely</td>
<td>4</td>
<td>Likely</td>
<td>The event is almost certain to occur and has occurred repeatedly in the construction industry</td>
</tr>
<tr>
<td>Likely</td>
<td>3</td>
<td>Likely</td>
<td>The event will probably occur in most circumstances</td>
</tr>
<tr>
<td>Unlikely</td>
<td>2</td>
<td>Unlikely</td>
<td>The event may occur only in exceptional circumstances</td>
</tr>
<tr>
<td>Very Unlikely</td>
<td>1</td>
<td>Very Unlikely</td>
<td>Very unlikely but remotely possible</td>
</tr>
</tbody>
</table>

Severity

Severity is the degree or extent of harm that can be caused by the hazards or the environment aspect as a result of an incident. Severity is classified as per the table given below.

<table>
<thead>
<tr>
<th>Severity Descriptions</th>
<th>VALUE</th>
<th>Result of Hazard to Personnel/ Environmental impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatality</td>
<td>4</td>
<td>Reportable Injury or illness resulting in more than 2 days off work / Permanent Total Disability</td>
</tr>
<tr>
<td>Major Pollution</td>
<td>3</td>
<td>Non-Reportable Lost Time Injury or illness resulting in more than 2 days off work</td>
</tr>
<tr>
<td>First Aid treatment. Minor Pollution</td>
<td>1</td>
<td>Injury or Illness requiring First Aid treatment. Minor Pollution</td>
</tr>
</tbody>
</table>

Matrix for Risk Assessment

- Once the likelihood and severity have been established, the risk / impact level can be determined.
To determine the risk / impact level, select the appropriate row for Severity and the appropriate column for Likelihood; the cell where they intersect indicates the Risk / Impact Level.

<table>
<thead>
<tr>
<th>Risk Rating (PxS)</th>
<th>Risk level</th>
<th>Recommended actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3</td>
<td>Low Risk</td>
<td>No additional risk control measures may be needed.</td>
</tr>
<tr>
<td>4-8</td>
<td>Medium Risk</td>
<td>Work can be carried out with Risk controls in place.</td>
</tr>
<tr>
<td>9-16</td>
<td>High Risk</td>
<td>Don’t start work Risk level must be reduced to Medium / low before commencing work.</td>
</tr>
</tbody>
</table>

When determining controls, or considering changes to existing controls, consideration shall be given to reducing the risks according to the following hierarchy:

- **Residual risks / impacts** are the remaining risks / impacts, for which the planned controls are not able to effectively remove or control. It shall be ensured that the residual risks / impacts are acceptable and manageable.

- The Engineer In charge shall prepare the Safe Work Method statement (form IM 12 B) in consultation with Project EHS In charge considering the existing & proposed risk controls listed in the activity EHS Risk Assessment at least 7 days prior to commencing work. While preparing the SWM, necessary inputs shall be taken from the relevant Construction EHS Standards given in the annexure.
- The Risk Assessment and SWM will be submitted together to Project EHS In charge for review and Project Head for approval. If the SWM is found to be unacceptable, then it will be returned to the Engineer In charge for revision and re-submission.

### Safe Work Method - Status clarification
- O ACC - Accepted (proceed with work)
- O AAN - Accepted As Noted (incorporate all comments prior to proceeding with work)
- O RAR - Revise And Re-submit (rejected)

### 5.4.3.4 Implement controls
- Commence work as per the approved Safe Work Method statement. Ensure availability of adequate resources to implement the controls while work execution.
- **Work Permit System**
- Work permit systems shall be implemented for the activities which are required to be performed under controlled environment. Follow the Work Permit System procedure (IM 14).

- **Daily Pre-start verification and Briefing to workmen**
  - The Engineer In charge shall complete the ‘Daily Pre-start verification and Briefing sheet ‘before starting the work every day.
  - ‘Pre-start verification’ ensures that the EHS risks involved in the day’s task are assessed and site condition verified for compliance in line with the Risk Assessment and SWM.
  - Before starting the day’s work, the workforce shall be briefed about the nature of the risks involved and the control measures implemented in line with the Risk Assessment and Safe work method statement. Language of briefing shall be understandable to the workforce.

### 5.4.3.5 Review & update

**EHS Inspection**
- Engineer In charge and Project EHS In charge shall conduct periodic inspections to verify the implementation of controls stipulated in the Safe Work method statement.

**Periodic Review & Update of EHS Risk Assessment**
- The EHS risk management system shall be reviewed periodically taking into consideration of field audit findings, incident reports and feedback from projects. This shall be carried out at all levels (cluster/project) during the EHS committee meetings. The EHS Risk Assessment shall be maintained up to date.
5.4 ASSOCIATED FORMS & TEMPLATES

• 1-A EHS Risk Register / Assessment
• 1-B Safe Work Method Statement
• 1-C Risk Management Register
• 1-D Daily Pre-start verification & Briefing Sheet
• 1-E Risk Management Audit

6. CONSTRUCTION SAFETY RULES

1. Keep your mind on your work at all times. No horseplay on the job. Injury or termination or both can be the result.
2. Personal safety equipment must be worn as prescribed for each job, such as: safety glasses for eye protection, hard hats at all times within the confines of the construction area where there is a potential for falling materials or tools, gloves when handling materials, and safety shoes are necessary for protection against foot injuries.
3. Precautions are necessary to prevent sunburn and to protect against burns from hot materials.
4. If any part of your body should come in contact with an acid or caustic substance, rush to the nearest water available and flush the affected part. Secure medical aid immediately.
5. Watch where you are walking. Don't run.
6. The use of illegal drugs or alcohol or being under the influence of the same on the project shall be cause for termination. Inform your supervisor if taking strong prescription drugs that warn against driving or using machinery.
7. Do not distract the attention of fellow workers. Do no engage in any act which would endanger another employee.
8. Sanitation facilities have been or will be provided for your use. Defacing or damaging these facilities is forbidden.
9. A good job is a clean job, and a clean job is the start of a safe job. So keep your working area free from rubbish and debris.
10. Do not use a compressor to blow dust or dirt from your clothes, hair, or hands.
11. Never work aloft if you are afraid to do so, if you are subject to dizzy spells, or if you are apt to be nervous or sick.
12. Never move an injured person unless it is absolutely necessary. Further injury may result. Keep the injured as comfortable as possible and utilize job site first-aid equipment until an ambulance arrives.
13. Know where firefighting equipment is located and be trained on how to use it.
14. Lift correctly - with legs, not the back. If the load is too heavy GET HELP. Stay fit. Control your weight. Do stretching exercises. Approximately twenty percent of all construction related injuries result from lifting materials.
15. Nobody but operator shall be allowed to ride on equipment unless proper seating is provided.
16. Do not use power tools and equipment until you have been properly instructed in the safe work methods and become authorized to use them.
17. Be sure that all guards are in place. Do not remove, displace, damage, or destroy any safety device or safeguard furnished or provided for use on the job, nor interfere with the use thereof.
18. Do not enter an area which has been barricaded.
19. If you must work around power shovels, trucks, and dozers, make sure operators can always see you. Barricades are required for cranes.
20. Never oil, lubricate, or fuel equipment while it is running or in motion.
21. Before servicing, repairing, or adjusting any powered tool or piece of equipment, disconnect it, lock out the source of power, and tag it out.
22. Barricade danger areas. Guard rails or perimeter cables may be required.
23. Trenches over five feet deep must be shored or sloped as required. Keep out of trenches or cuts that have not been properly shored or sloped. Excavated or other material shall not be stored nearer than two feet from the edge of the excavation. Excavations less than 5 ft may also require cave in protection in some instances.
24. Use the “four and one” rule when using a ladder. One foot of base for every four feet of height.
25. Portable ladders in use shall be equipped with safety feet unless ladder is tied, blocked or otherwise secured. Step ladders shall not be used as a straight ladder.
26. Ladders must extend three feet above landing on roof for proper use.
27. Defective ladders must be properly tagged and removed from service.
28. Keep ladder bases free of debris, hoses, wires, materials, etc.
29. Build scaffolds according to manufacturers' recommendations and MIOSHA Construction Safety Standard Part 12 - Scaffolding.
30. Scaffold planks shall be properly lapped, cleared or otherwise secured to prevent shifting.
31. Use only extension cords of the three-prong type. Use ground fault circuit interrupters at all times and when using tools in wet atmosphere (e.g. outdoors) or with any temporary power supply. Check the electrical grounding system daily.
32. The use of harnesses with safety lines when working from unprotected high places is mandatory. Always keep your line as tight as possible.
33. Never throw anything "overboard." Someone passing below may be seriously injured.
34. Open fires are prohibited.
35. Know what emergency procedures have been established for your job site. (Location of emergency phone, first aid kit, stretcher location, fire extinguisher locations, evacuation plan, etc.)
36. Never enter a manhole, well, shaft, tunnel or other confined space which could possibly have a nonrespirable atmosphere because of lack of oxygen, or presence of toxic or flammable gas, or has a possibility of engulfment by solids or liquids. Make certain a qualified person tests the confined area with an appropriate detector before entry, that the necessary safety equipment is worn. Standby person may be required to be stationed at the entrance.

7. CONCLUSION

In my project is the Risk management system using software’s like C++, JAVA. To improve the EHS performance, project performance to lead factor. The EHS performances lag implementation following risk management system. All incident / accidents are preventable unless good safety culture follows at project.
1. All near miss / First aid case report shall be reporting and investigate in time.
2. All near miss / first aid case shall be circulated to all staff.
3. Near miss campaign shall be conducted once in a month.
4. Rewards shall be given to staff and workmen for reporting near miss.
5. Reporting system shall be simple and easy to all.
6. All NM and FA case shall be discussed in EHS committee meeting.
7. Effective EHS committee meeting shall be conducted once in a month.
8. Workmen rewards shall be issuing for safety conscious.

Engineer In charge and Project EHS In charge shall conduct periodic inspections to verify the implementation of controls stipulated in the Safe Work method statement. The EHS risk management system shall be reviewed periodically taking into consideration off-field audit findings, incident reports and feedback from projects. This shall be carried out at all levels (cluster/project) during the EHS committee meetings. The EHS Risk Assessment shall be maintained up to date.

8. REFERENCE