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Risk Assessment and Control in Faculty of Engineering and Technical Studies at University of Kordofan in SUDAN

Yaseen Mohammed Mosa Salih
Department of Chemical Engineering, University of Kordofan, SUDAN
yaseen.awal@gmail.com

Abstract

A risk assessment is the process of evaluation risk to workers' safety and health from workplace hazards. This study controlled and assessment the risk in faculty of Engineering, Kordofan University (Sudan). Large number of material and equipment can cause corrosion and explosion, in health, safety and environmental (HSE) of the university. Evaluation of mean time between failures (MTBF) and control of substances hazard to health (COSHH), also with the known of hazard and operability (HAZOP), expected that the system of cooling by water in the faculty can be controlled, and the failure on average is once every 0.43 year, which it considered high.

Keywords: *Risk assessment, safety, university of Kordofan, Hazard and operability.*

1. Introduction

Risk assessments are central to managing health and safety in the University of Kordofan (was founded in 1990, Sudan), to provide practical information on how to carry out risk assessments and risk assessment logs. Because of the problem of chemical material in explosion, and water in corrosion, this research control the protection of the university equipment's.

Risk assessment includes incident identification and consequence analysis. Incident identification describes how an accident occurs. It frequently includes an analysis of the probabilities. Consequence analysis describes the expected damage.

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This includes loss of life, damage to the environment or capital equipment, and day's outage [1].

Risk assessment can help you to organize and manage risks in three stages:

1. Identifying underlining hazards.
2. Logically determining the risk of harm.
3. Considering what could be done to reduce or eliminate that risk.
4. A hazard is defined as the potential to cause harm; risk is the likelihood that harm, (illness or injury) will actually occur.

A main principle of risk assessments is they should take place before_any changes are made. Risks should be assessed and control measures put into action before_new work is introduced or systems are changed. The process should influence budgets and allocation of resources, rather than being an afterthought when the decisions have already been made [2].

1.1 Risk assessment overview:

The regulation of tasks in schools and services means mainly managers are responsible for ensuring risk assessments are in place. They must ensure suitable and sufficient risk assessments are carried out and regularly reviewed, and that records are kept for work in their areas of responsibility.

Risk assessment tasks may be delegated as long as the risk assessor is competent [2].

Risk assessments must be carried out for all work that includes significant risks. Trivial risks can be ignored. Risk assessments must be reviewed regularly every two years as a minimum immediately following a serious incident or

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where there is reason to suspect it is no longer valid [2].

2 Protective and preventative measures

Control measures can be preventative (to prevent the hazard arising in the first place) or protective (to protect employees from existing hazards). Of course, measures identified in the risk assessment must be put into action if the process is to have any value.

Employers are also required to make an assessment of the risks to other people not in their employment who may be affected by the work activity [4].

Risk assessments can produce a number of possible control measures but the final decision is a tradeoff between the level of risk, cost and the time and effort of applying the control. The choice of control should be guided by the hierarchy of risk control principles:

1. Elimination,
2. Substitution,
3. Isolation,
4. Reduction,
5. Information, instruction, training and supervision, and
6. Personal protective equipment.

Where more than one option is available for a similar degree of risk control, consider which the most cost effective option is.

Failure to implement control measures without adequate documented justification (or failure to ensure that risk assessments are carried out at all) could be highlighted as a potential contributory factor in the incident.

Computer program are very important to control cooling risk

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water. Having a program to drain or flush the pipe at regular intervals, to remove the stagnant water [4].

2.1 Carry Out a Risk Assessment

The University will provide training for staff carrying out risk assessments - the type of training will depend on the complexity of the risk assessments.

A competent person is someone who has knowledge of the:

- Work involved through personal experience,
- Principles of risk assessments and preventing risks, and
- Specific subject under assessment, through training.

Risk assessor courses are currently provided centrally, and managers who have passed this course should be competent to carry out a basic risk assessment. Additional professional advice is available from health and safety services for the more complex and technical areas of risk assessment such as electricity, noise and vibrations.

2.2 Risk assessment log

Each faculty, school or service should create and maintain an up-to-date risk assessment log. This is a central record of all the risk assessments carried out.

The purpose of the risk assessment log is to enable information to be exchanged within schools and across the University, avoiding duplication of effort and creating consistency. The log will also:

- Identify common assessments, allowing best practice to be shared through a consistent approach and easy exchange of information,
- Highlight areas that still require assessment,

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- Highlight assessments that are due for review,
- Track outstanding actions arising from the risk assessment,
- Target key areas for audit, and
- Provide an effective monitoring tool for senior management.

2.3 Form should be used

In order to keep consistency across the University and within schools and services, the form for recording assessments has been agreed as a minimum standard. If this form is filled in correctly, the assessment will meet the legislative requirements of being "suitable and sufficient".

The form should be used for all risk assessments except for the following where other specific forms are available,

- Fire,
- Display screen equipment,
- Manual handling,
- Control of substances hazardous to health (COSHH),
- First aid,
- Field trips,
- Genetic modification,
- Ionizing Radiation,
- Lasers,
- Lone working, and
- Pregnant workers

Some of these specific risks may be included in a general risk assessment, for example manual handling and fire may be identified in a general office risk assessment. Blank risk assessment forms are available in paper format and electronically from health and safety services, (see appendix 1).

2.4 Risk assessed

The types of assessment listed below show the diversity of hazards, but this list is not

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exhaustive. Assessors can select the type of risk assessment that best suits their service or use a combination. Risk assessments can be cross-referenced to avoid replicating information, so an assessment for “aqua-aerobics” would not need to contain all the information in the "running and maintenance of a swimming pool" assessment, tables 1 and 2 bellows.

Table 1. Hazard specific and activity specific

Hazard specific	Activity specific
• Fire or explosion • Electricity • Noise or vibration • Heat or cold • Radiation • Lighting • Vehicle movement	• Cash handling • Events • Educational visits • Organized trips • Minibuses • Working at heights – e.g. Using ladders • Reception duties
• Compressed air • Falling objects • Slippery, uneven or worn floors • Obstructions and projections • Repetitive hand or arm movements • Handling sharps - broken glass, razors • Violence and aggression	• Cleaning • Office moves • Fieldwork

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Table 2. Equipment and Person specific

Equipment specific	Person specific
• Use of hand tools • Use or maintenance of electrical items • Still saw	• New and expectant mothers • Young workers • Employees with a disability

2.5 Combination

A kitchen risk assessment could include: knives, hot water, steam, regeneration ovens, microwave ovens, grills, serving counters, water boilers, dishwashing machines (may link in with COSHH), waste disposal units, food mixers and processors, deep fat fryers, ovens, ranges, fan assisted ovens, heated sinks, gravity feed slicing machines, slips, electricity etc.

- A general building assessment could include: asbestos, maintenance of buildings, security, etc.

Legislation and guidance state that you can ignore trivial risks or normal life risks, unless the work activity compounds the risk or significantly alters it.

The calculation of the maximum probable property damage (MPPD) and the maximum probable day's outage (MPDO). This is a form of consequences analysis. However, these numbers are obtained by some rather simple calculations involving Published correlations. Hazard and operability (HAZOP) studies provide information on how a

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particular accident occurs. This is a form of incident identification. No probabilities or numbers are used with the typical HAZOP study, although the experience of the review committee is used to decide on an appropriate course of action.

2.6 Review of Probability Theory

Equipment failures or faults in a process occur as a result of a complex interaction of the individual components. The overall probability of a failure in a process depends highly on the nature of this interaction. In this section we define the various types of interactions and describe how to perform failure probability computations.

Data are collected on the failure rate of a particular hardware component. With adequate data it can be shown that, on average, the component fails after a certain period of time. This is called the average failure rate and is represented by *p* with units of faults time. The probability that the component will not fail during the time interval (0, t) is given by a Poisson distribution:

$$R(t) = e^{-\mu} \quad (1)$$

$$t \rightarrow \infty$$

$$f(t) = \frac{dp(t)}{dt} = \mu\, e^{-\mu t} \quad (2)$$

$$p = \prod_{i=1}^{n} p_i \quad (3)$$

Where;

n is the total number of components and

P is the failure probability of each component.

P_i is failure probability

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R is reliability

This rule is easily memorized because for parallel components the probabilities are multiplied. The total reliability for parallel units is given by

$$R = 1 - \prod_{i=1}^{n}(1 - R_i) \quad (4)$$

Where: R_i is the reliability of an individual process component.

Process components also interact in series. This means that a failure of any single component in the series of components will result in failure of the process. The logical OR function represents this case. For series components the overall process reliability is found by multiplying the reliabilities for the individual components:

$$R = \prod_{i=1}^{n} R_i \quad (5)$$

$$P = \sum_{i=1}^{n} P_i \quad (6)$$

$$P(A \; or \; B) = P(A) + P(B) \quad (7)$$

The time interval between two failures of the component is called the mean time between failures (MTBF) and is given by the first moment of the failure density function:

$$E(t) = \text{MTBF} = 1 / \mu \quad (8)$$

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3. Material and Method

3.1 Planning the risk assessment process

A corporate risk assessment form has been agreed, a bank of new generic risk assessments will be posted on the university website (www.kordofan.edu.sd). This will avoid reinventing the wheel and also enable best practice to be shared.

In some cases they might need professional help from HSE services or the occupational health service. Risk assessment process have six steps which are:

Step 1 - Look for hazards,

Step 2 - Decide who might be harmed and how,

Step 3 - Analyzing the risk,

Step 4 - Record the findings and put measures in place to control the risks,

Step 5 - Implementing and prioritizing action, and

Step 6 - Communicate the findings to staff.

3.2 Analyzing the risk

To help analyze risk, the University uses a matrix scoring system. Numerical scores are given to the severity and likelihood of risks and these scores are multiplied to get a rating for the risk. This means the risk rating is a measure of the likelihood that harm from a particular hazard will occur, taking into account the possible severity of such an occurrence.

$$\text{Risk} = \text{Severity} \times \text{Likelihood} \qquad (9)$$

For the initial risk evaluation, consider the risks identified in the worst case scenario before any controls are applied.

Electricity is a hazard, for example - It can kill but the risk of it doing so in an office environment is low

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providing the components are insulated, the metal casing is properly earthed and appliances are used correctly and tested.

3.3 The hierarchy of control

Control measures identified by the risk assessment, whether protective or preventative, must be implemented in line with the following hierarchy of control. In many cases a combination of control measures will be needed.

- **Elimination** - is it possible to avoid the risk altogether? (sE.g. requesting a delivery service to an office instead of reception to prevent staff from manual handling).
- **Substitution** - change the way you do the work, but take care not to introduce new risks (e.g. using a safer chemical).
- **Isolation** - combat risks at the source and prevent access to the hazard (e.g. guarding machinery).
- **Reduction** - reduce the number of employees at risk or reduce the extent of exposure.
- Use **information (**written procedures, safe systems of work), instruction, training and supervision - ensure employees understand what they must do and when, how they must do it and what activities are prohibited.
- Use **personal protective equipment**, but only as the last resort and only after all other measures have been implemented.

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4. Result and Dissections

Table 3, Failure Rate Data for Various Selected Process Components:

Instrument	Faculty/year
Level measurement (liquid)	2.00
Level measurement (solid)	6.2
pH meter	7.2
Flow switch	0.6
Hand valve	0.2
Controller	0.3
Pressure measurement	1.2
Pressure relief valve	0.3
Pressure switch	0.3
Indicator lamp	1.1
Stepper motor	0.05
Strip chart recorder	0.01

Table 4, Results of severity

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Hazard severity	Problems	Points rating
Very high	Causing multiple deaths and widespread destruction eg. fire, building collapse.	5
High	Causing death, serious injury or permanent disability to an individual.	4
Moderate	Temporary disability causing injury or disease capable of keeping an individual off work for three days or more and reportable under RIDDOR (Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995).	3
Slight	Minor injury, which would allow the individual to continue work after first aid treatment on site or at a local surgery. The duration of the stoppage or treatment is such that the normal flow of work is not seriously interrupted.	2
Nil	Very minor injury, bruise, graze, no risk of disease.	1

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Table 5, Likelihood

Hazard likelihood	Problems	Points rating
Inevitable	If the work continues as it is, there is almost 100% certainty that an accident will happen, for example: • A broken stair or broken rung on a ladder • Bare, exposed electrical conductors • Unstable stacks of heavy boxes	5
Highly likely	Will happen more often than not. Additional factors could precipitate an incident but it is still likely to happen without this additional factor.	4
Possible	The accident may occur if additional factors precipitate it, but it is unlikely to happen without them.	3
Unlikely	This incident or illness might occur but the probability is low and the risk minimal.	2
Remote possibility	There is really no risk present. Only under freak conditions could there be any possibility of an accident or illness. All reasonable precautions have been taken - This should be the normal state of the workplace.	1

Table 6, Risk Range

Risk Rating Score	Action
1-4	Broadly acceptable - No action required
5-9	Moderate - reduce risks if reasonably practicable
10-15	High Risk - priority action to be undertaken
16-25	Unacceptable -action must be taken IMMEDIATELY

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Table 7, Calculation of P,

Component	Failure rate μ (Faults / yr)	Reliability $R(t) = e^{-\mu}$	Failure probability P = 1 - R
Control valve	0.60	0.55	0.45
Controller	0.29	0.75	0.25
DP cell	0.24	0.24	0.76

The overall reliability for components in series is computed using Equation (4) The result is

R = (0.55) (0.75) (0.25) = 0.10

The failure probability is computed from:

P = 1 - R = 1 - 0.10 = 0.90/yr.

The overall failure rate is computed using the definition of the reliability (Equation (1)):

$0.10 = e^{-\mu}$

μ = -ln(0.1 0) = 2.30 failures/yr.

The MTBF is computed using Equation (7):

MTBF =1 /μ = 0.43 yr.

This system is expected to fail, on average, once every 0.43 yr.

Conclusion

The final result of mean time between failure in the faculty equipment is high (0.43 once every year), because there's no proper applying for health, safety and environmental (HSE) to risk assessment guidance.

Recommendation

- It's recommended that more studies in other work places like ministries and offices to evaluate and control risks not only in factories.
- Schedule training with proper program for all faculties in the university will increase the control of risk assessment.

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