NOVATEUR PUBLICATIONS
INTERNATIONAL JOURNAL OF INNOVATIONS IN ENGINEERING RESEARCH AND TECHNOLOGY [IJIERT]
ISSN: 2394-3696
VOLUME 3, ISSUE4, APR.-2016

IMPLEMENTATION OF INDUSTRIAL SAFETY

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ABSTRACT

In today's world, technology has influenced human beings by various means in their life. Mainly the technology which is helpful in providing the safety as well as simple operation to the human being is known as automation. Nowadays, industrial safety is considered as an important factor and is implemented as per the risk assessment in various industries. Risk assessment is carried out using SIL & CAT level. Safeguarding the hazardous area will usually involve the use of some kind of control system, and the Machinery Directive gives various requirements for the performance of the control system. In particular it states "Control system must be designed and constructed in such a way as to prevent hazardous situation from arising". Various safety devices are available in market, which are useful in providing the safety for different operations. Some of the safety devices used in the prototype are safety light curtains and pressure sensitive mat. According to government norms the safety rule should be strictly followed. A survey gives clear idea of industrial accidents that they are mainly occurred due to lack of safety. Accidents caused due to man-made errors can be dangerous enough, to cause a permanent damage to human being. Such accident can be avoided by following certain safety standards. Generally industry use safety PLC's to provide Personal as well as Machine safety. Considering these requirements, a standard PLC Ladder logic is developed. This report is beneficial in industrial applications where safety is to be provided.

KEY WORDS: Automation, SIL & CAT, Light curtains , Pressure mat

INTRODUCTION

Industrial safety can be defined as a process or a procedure provided to any human being working on a particular machine with the necessary requirements and certain safety rules for security of their lives and also from causing an injury. The Machine safety is one of the most rapidly growing areas of importance in industrial automation .New and improved safety strategies offer manufacturers a way of improving their productivity and competitiveness in the market. Safety becomes an integrated part of machine functionality, rather than after-thoughts added to meet regulations. Accidents occurred due to improper safety procedures not only result into a economical loss of the company, but it also affects lives of the people. This safety can be achieved by providing proper equipment to the workers while on the job and by

using automation technology for designing safety system. A prototype is designed which provides a reliable safety to any person working over that machine.

NEED OF SAFETY IN THE INDUSTRY

Nowadays safety in the industry is considered as an important factor for the machine safety and the workers safety. Workers, on which the industries run, are very much valuable and necessary. Accidents taking place in the industries are increasing a lot which leads to a heavy loss, affecting production and human health. As well as the moral obligation to avoid harming anyone, there are laws that require machines to be safe, and sound economic reasons for avoiding accidents. To minimize the number of accidents various safety provisions are implemented with the help of automation. Safety has evolved from being a cost burden and "necessary evil" to a strategy for improving productivity and reducing downtime. Safety must be taken into account right from the design stage and must be kept in mind at all stages in the life of a machine: design, manufacture, installation, adjustment, operation, maintenance and eventual scrapping.
It also provides the following objectives listed below:
(1) Provide workers with a safe work environment.
(2) Conduct routine/regular workplace inspections.
(3) Provide Personal Protective Equipment.
(4) Develop and implement safe work procedures and rules.
(5) Provide on-going safety training
(6) Enforce safety rules and appropriate discipline.
(7) Provide on-going property conservation practices.

IMPLEMENTATION OF INDUSTRIAL SAFETY

Safety can be provided to the workers by finding out risk evaluation of hazard area and design the safety system using PLC as per the risk level obtained. Risk evaluation can be obtained by using standards such as:

1. SIL(Safety Integrity Level),
2. CAT (Category).

After that engineer decides what level of safety is needed to a hazard area. Once it is finalized, ladder program is made for a PLC. For an example, an alarm would be raised to alert worker if he enters into a danger zone. This can be achieved by using certain devices such as different kinds of sensors, switches and alarms. The safe operation of a major hazard installation should be the responsibility of works management. Works management should ensure that the major hazard installation is always operated within the limits of intended design. Works management should take account of all hazards identified in the hazard analysis together with possible technical and organizational control measures.

Measures used to control hazards should include:

1. Component design;
2. Manufacture of components;
3. Assembly of the installation;
4. Process control;
5. Safety systems;
6. Monitoring;

7. Management of change;
8. Inspection, maintenance and repair;
9. Training of workers;
10. Supervision;
11. Control of contract work.

LITERATURE SURVEY

Machine safety is one of the most rapidly growing areas of importance in industrial automation. New and improved safety strategies offer manufacturers a way of improving their productivity and competitiveness in the market. Safety becomes an integrated part of machine functionality, rather than after-thoughts added to meet regulations. National laws of the European Union require that machines meet the Essential Health and Safety Requirements (EHSR) defined in the Machinery Directive 2006/42/EC. Harmonized standards listed under the Directive are one preferred way of showing compliance. This means that all new machinery must fulfill the same legal requirements when supplied throughout the EU. The same standards are also recognized in many areas outside Europe, for example, the equivalency charts facilitates machinery trade and machine shipments between countries within and even outside the EU. In this direction, we referred 'Safety and functional safety', published by ABB Pvt. Ltd. to study Role of the Machine directives, in order to estimate level of safety required for a particular machine and we studied how should be the flow for designing a safety system. From the paper '4th revised and expanded edition of the Pilz Safety Compendium', by the authors Christian Bittner, Holger Bode, Andreas Hahn , from which we studied the two standards SIL (Safety integrity level) and CAT(Category), which are used to estimate the risk evaluation. We referred the 'Allen Bradley mat guard manual', which clearly mentions the procedure for installing the safety mat and to calculate the required area of the same.
We also referred the books like 'Safe machinery handbook' published by Schneider Electric and studied various safety devices like safety relay, safety PLC, light curtains, safety interlocks. The book 'Prevention of major industrial accidents' published by International Labour Office Geneva, was referred to get general idea of the accidents occurring in various industries.

INDUSTRIAL ACCIDENT

Some of the costs are obvious, such as sick pay for injured employees, whereas some costs are harder to identify. The Health and Safety Executive (HSE) give an example of an accident at a drilling machine that resulted in costs to the business of £45 000 (HSE INDG355). However this does not include some of the less obvious costs, and some estimates amount to double that figure. An accident analyzed by Schneider Electric Ltd, the outcome of which was a reversible head injury, cost the employer some £90 000, of which only £37 000 was insurable. The full financial impact can include increase in insurance premiums, lost production, lost customers and even loss of reputation.
Some risk reduction measures can actually increase productivity; for example the use of light curtains to protect access points of machines can allow easier access for loading and unloading; zoning of isolation devices can allow parts of a machine to be shut down for maintenance while other parts remain productive.

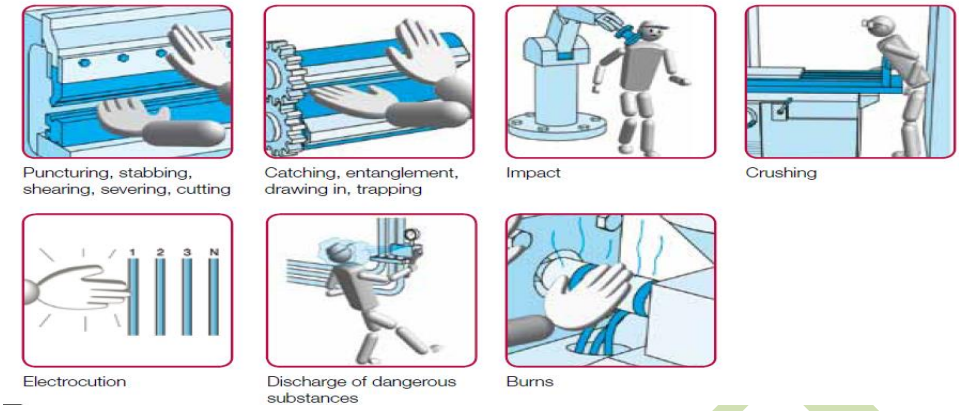

Figure 1: Typical hazards

SAFETY PLAN

A safety plan for meeting the requirements of the Machinery Directive is specified in EN62061.It identifies all relevant activities, describes the policy and strategy for fulfilling functional safety requirements, identifies responsibilities, identifies or establishes procedures and resources for documentation, describes a strategy for configuration management, and includes plans for verification and validation. This plan needs to be designed and documented for each safety system and updated when necessary. When a safety plan according to EN 62061 has been created, the more practical aspects can begin. These follow the step-by-step procedure summarized in Table 1, starting with risk assessment and reduction.
Each of these seven steps is explained in more detail below.

Step	Task
Step 1: Assessment and risk reduction	Analyse risks and evaluate how to eliminate or minimize them (3 steps strategy see EN ISO 12100-1)
Step 2: Establish safety function requirements	Define what functionality and safety performance is needed to eliminate the risk or reduce it to an acceptable level.
Step 3: Implement functional safety	Design and create the safety system functions
Step 4: Verify functional safety	Ensure that the safety system meets the defined requirements
Step 5: Validate functional safety	Return to risk assessment and ensure that the safety system actually succeeds in reducing risks as specified
Step 6: Document functional safety	Document the design and produce user-documentation
Step 7: Prove compliance	Prove the machine‘s compliance with EHSR of the Machinery Directive through compliance assessments and technical file

TYPES & SELECTION OF SAFETY DEVICES

1. PRESSURE SENSITIVE MAT

The pressure sensitive mat system is designed for use as a safety product in an industrial environment by professional personnel. It provides protection against risks which can be eliminated by the isolation of electrical power when an operator is in the vicinity of the hazard.

2. LIGHT CURTAIN

By finger, hand or body (upto 14mm, upto 30mm and above 30mm resolution) Light curtains are typically used in material handling, packaging, conveyor, warehousing and other applications. Light curtains are the optoelectronic devices that are used to safeguard the personnel in the vicinity of moving machinery with the potential to cause harm such as(but not limited to)presses, winders, & palletizers. Light curtains can used as an alternative to mechanical barriers &other form of tradition machine guarding .By reducing the need for physical guards &barriers. Light curtains can increase the maintainability of the equipment they are guarding. The operability and the efficiency of the machinery can also be increase to a large extend.

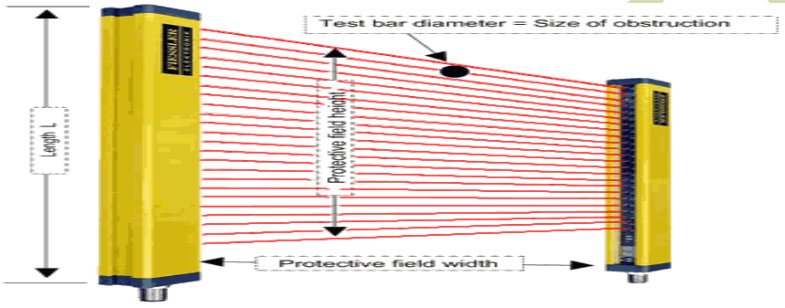

Figure 2: light curtain

CALCULATING THE SAFETY DISTANCE BASED ON ISO13855 (EN999)

Safety distance (S) = Person's approach speed × response time + additional distance due to the sensor's detection capability

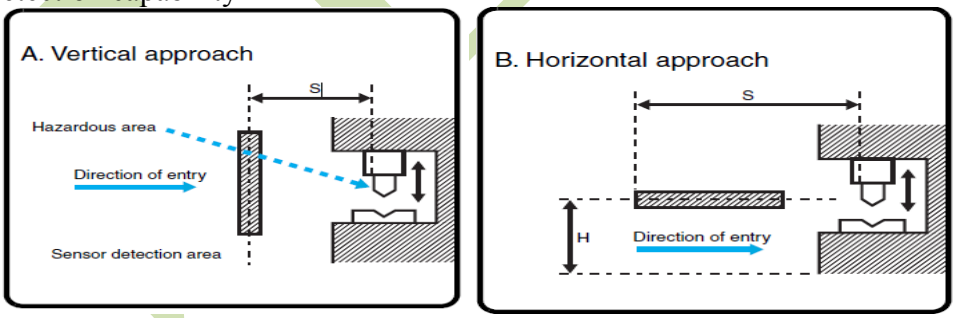

Figure 3 : Vertical approach and horizontal approach

FINGER OR HAND DETECTION

E.g. $S = (K \times T) + 8\,(d-14)$ $d \leq 40$
K = 2,000 mm (assuming entry speed of finger)
T = Machine's maximum stop time + Light Curtain response time
d = Light Curtain's minimum detection object value.
Note: if S = ≤ 100 mm, S = 100 mm
If S = ≥ 500 mm, recalculate with K = 1,600
If the calculation result is S ≤ 500 mm, S = 500 mm

BODY DETECTION

$$S = (K \times T) + 850 \quad 40 < d \leq 70$$

K = 1,600 mm (assuming person's walking speed)

T = Machine's maximum stop time + Light Curtain response time

C = 850 mm (assuming entry with an outstretched arm)

$$S = (K \times T) + (1{,}200 - 0.4\ H)$$

K = 1,600 mm (assuming person's walking speed)

T = Machine's maximum stop time + Light Curtain response time

H = Light Curtain installation height

$$= 15(d - 50)$$

Note: 1- H must not exceed 1,000 mm

Note: 2- f H exceeds 300 mm (200 mm for non-industrial applications), there isa danger of someone slipping under. This must be considered in the risk assessment.

Note: 3- When detecting entry with a Safety Mat. S = (1,600 × T) + 1,200

LADDER DIAGRAM

Figure 4 : ladder diagram

SCADA SCREEN

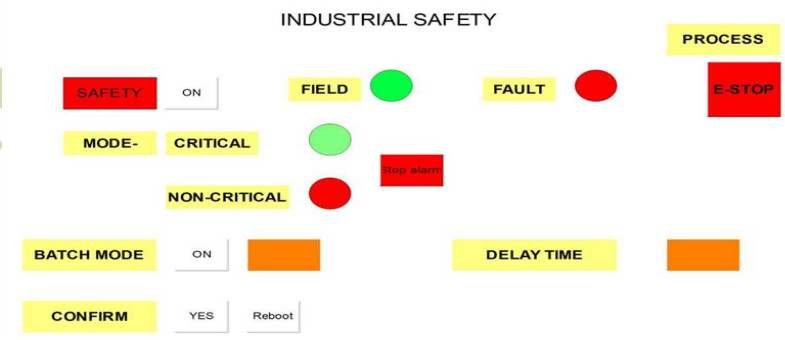

Figure 5 : SCADA screen

FUTURE SCOPE

RFID sensors can be used to detect tools carried by worker in an particular area and even it is used to detect worker position. White syndrome can be avoided for a person working on an heavy drill machine by detecting pressure subjected to the human hands. By providing an firewall, PLC and SCADA system can be protected from an cyber crime. Wireless communication system can be developed for communication of RTU, PLC, Central control room; which would reduce cost of wiring.

CONCLUSION

We have designed the standard safety plan, using the EU norms and machine directives. As per the above safety plan described, we have designed the safety system prototype which is usually used in automobile industries. Our system design is flexible which can be used to provide safety for both critical operation as well as non-critical operation with minimum cost. As per our prototype, ladder program is designed and it has successfully given the desired results. Mentioned above safety plan is validated to design safety system for the prevention of possible cases which are harmful to human activity and other accidents which are occurring in industrial premises. Hence we have successfully provided safety as well as reduced the possibility of accidents.

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