Accidents, Incidents & PPE

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Rev.1

Rua Afonso César de Siqueira 106, Sala 1402-A
São José dos Campos – SP – Brazil – Phone: +55.12.9.9673.1960

site: www.matecengenharia.com.br contact: almeida@matecengenharia.com.br

1. SCOPE

This document brings some comments on the definitions of “Accident” and “Incident”, as well as on the role of the PPE in these two events. We will not discuss domestic accidents/incidents, but only those related to an industrial activity.

2. ACCIDENTS & INCIDENTS

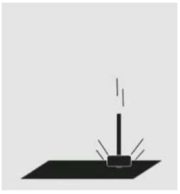
Some companies do not distinguish between the term “incident” and “accident”, considering all abnormal events as an “accident”. However, it is possible to make a distinction between these two terms based on the consequence of each event. Although each company may have its own definitions of incidents and accidents, most of the literature available on this subject uses the following definitions:

ACCIDENT: is an unexpected and undesirable event that causes significant personal, material, financial and/or environmental damage and that occurs unintentionally.

INCIDENT: is also an unexpected and undesirable event, occurring unintentionally, that however does NOT cause any damage or the damage caused is insignificant. There is a special type of incident that is the one that did not turn into an accident by mere chance or pure luck. This type of event is called a **“NEAR MISS”**.

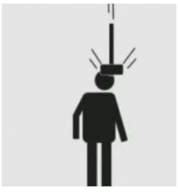
The following example illustrates these definitions:

Consider the event where an employee, working on a scaffold 5 meters high, drops his hammer on the ground. If the area is isolated and there is nobody in the vicinity, the hammer hits the ground without causing any damage. This event is recorded as an “INCIDENT”.



Consider the same previous event, but with a person passing through the area and the hammer hitting the ground near that person. We consider that, by pure luck, there was no personal injury and this event is recorded as a “NEAR MISS”.

Still considering the same scenario, this time the hammer hits a person who is passing in the area. The person will certainly be harmed and the event is recorded as an “ACCIDENT”.



Note that the definitions adopted include the term “significant”, used to distinguish between accidents and incidents. In order not to have a too subjective definition, it is common for companies to quantify what is considered significant and what is not. Among the various methodologies for carrying out this quantification, we highlight the use of the Risk Matrix (see document already published on LinkedIn as TEC.510) and the HRN – Hazard Rate Number (document TEC.533).

Specifically in Brazil, the current legislation defines what is considered an accident (Law N° 8213 of July 24, 1991 – Article 19) as being *an event that causes bodily injury or functional disturbance that causes death or the loss or reduction, permanent or temporary, of work capacity*. In other words, any event that prevents a person from returning to their work activity is classified as an accident. On the other hand, minor events, even if they require medical intervention, but which do not prevent the person from immediately returning to their activities, are not considered an accident according to Brazilian legislation.

3. IMPORTANCE OF RECORDING INCIDENTS AND NEAR MISSES

A fundamental part in any accident control and reduction program is the knowledge of the company's deficiencies in its various areas of activity. The fact that an undesirable event has been occurring multiple times is a clear sign that the control and prevention measures in place are inadequate.

Lessons learned from incidents and near misses can help us prevent the occurrence of serious accidents. However, the knowledge and experience gained from previous occurrences are only possible if such occurrences are recorded and analysed, in order to obtain:

• An understanding of how and why the events occurred.

• An understanding of the ways in which people may be exposed to conditions that may affect their physical integrity.

• An understanding of how things are done “in practice” (identification of “shortcuts” used by employees to make the work faster or easier).

• An understanding of the deficiencies of the risk management program in use.

It is important to emphasize that the purpose of recording and investigating incidents, near-misses and accidents is not to point fingers, but rather to:

• Prevent the reoccurrence of similar events.

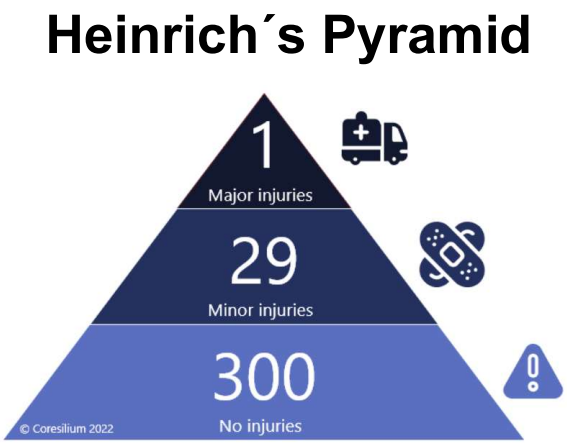
• Prevent the reduction or even interruption of business.

• Demonstrate an attitude in favour of operational safety – it is important for the operational personnel to participate in the definition and implementation of new safety measures.

• Enrich the company's database with the experience gained from the investigations carried out and dissemination of improvements made, aiming to implement similar measures in other areas/units of the company.

Throughout the 20th century, several studies were conducted seeking a correlation between the number of incidents and near-misses to the major accidents. These correlations were presented in the form of pyramids by several authors, among which we highlight:

• **Heinrich's Pyramid:** developed in the 1930s and also called the Heinrich Triangle, this pioneering model was created by Herbert William Heinrich to demonstrate the relationship between the number of minor, serious and fatal workplace accidents. According to Heinrich, for every fatal or very serious accident, there are 29 minor accidents and 300 incidents without injuries. Heinrich's Pyramid has been heavily criticized for simplifying the relationship between types of accidents, since not all minor accidents lead to serious accidents. In addition, the pyramid does not take into account the human and organizational factors, which can divert attention from deeper systemic conditions that need to be addressed to improve safety as a whole.



• **Bird's Pyramid:** Bird's Pyramid was developed by Frank Bird in the 1960s and is an extension of Heinrich's Pyramid. It also shows the relationship between accidents of different severity, but with a more detailed classification. Bird identified that for every fatal or serious accident, there are 10 minor accidents, 30 cases of material damage without injuries and 600 incidents or near misses, thus showing the importance of addressing all levels of incidents. With Bird's pyramid, there was an advance in the detailing of event categories, including material damage and expanding the scope beyond human injuries. This model brought a more systemic view, considering organizational factors as fundamental causes of accidents, going beyond individual behaviours.

• **DuPont Pyramid:** The DuPont Pyramid set a new standard by placing safety culture and human behaviour at the centre of prevention. Focusing on identifying and correcting deviations (unsafe acts and conditions), the model emphasizes shared responsibility and the importance of a collective safety mindset. It combines organizational culture and behavioural prevention to align individual values and actions. To this end, the DuPont pyramid began to consider deviations in the following proportion: 1-30-300-3,000-30,000, i.e., for the occurrence of 1 fatality, there would be 30 accidents with lost time, 300 without lost time, 3,000 incidents and 30,000 deviations.

DuPont Pyramid

• **ConocoPhillips Marine Pyramid:** More recently, in 2003, ConocoPhillips Marine added to the work of Heinrich and Bird through an internal study that showed an increase in the ratio between near misses and major injury. The study found that for every major injury or serious incident, there were an estimated 3,000 near misses. The increased distance in the total numbers of near misses to major injuries thus showcased drastic improvements to safety culture and mishap prevention in the workplace. However, the ConocoPhillips study also uncovered an additional layer to the safety pyramid, revealing that for every major injury there were more than 300,000 at-risk behaviours. At-risk behaviours include bypassing safety components on machinery and tools or eliminating time-consuming safety steps.

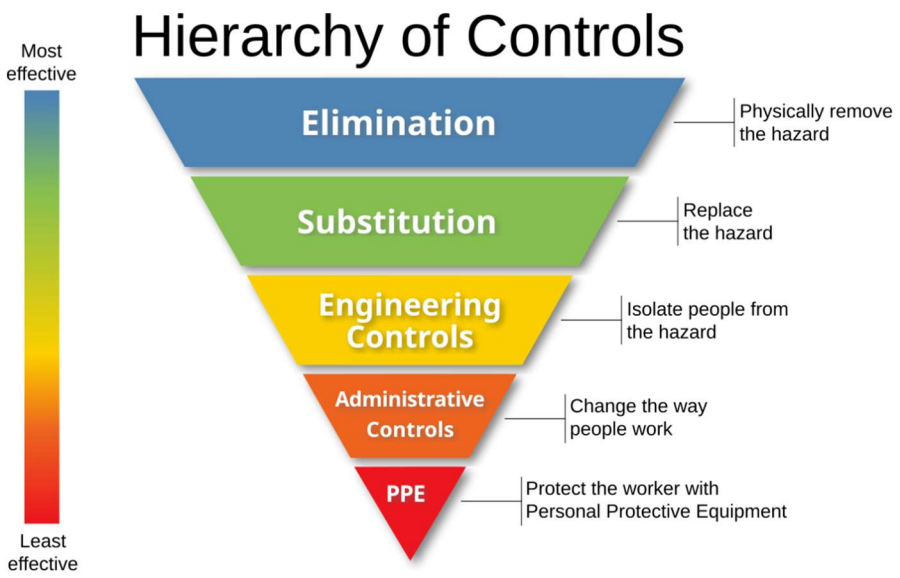
ConocoPhillips Pyramid

It is important to highlight that the fixed proportion of the pyramids is a correlation and not a causality, that is, reducing deviations tends to reduce the probability of serious accidents, but it does not guarantee the elimination of serious accidents, since other unpredictable factors can influence. However, the pyramids are valuable instruments to show the importance of recording safety-related events and dealing with them quickly and appropriately.

4. THE FUNCTION OF THE PPE

As previously stated, the knowledge, recording and investigation of all abnormal events is fundamental in any organization's safety program. With this information, it is possible to define the layers of protection necessary to minimize the risk of a major event occurring.

The hierarchy of protection to be adopted, normally follows the following order:



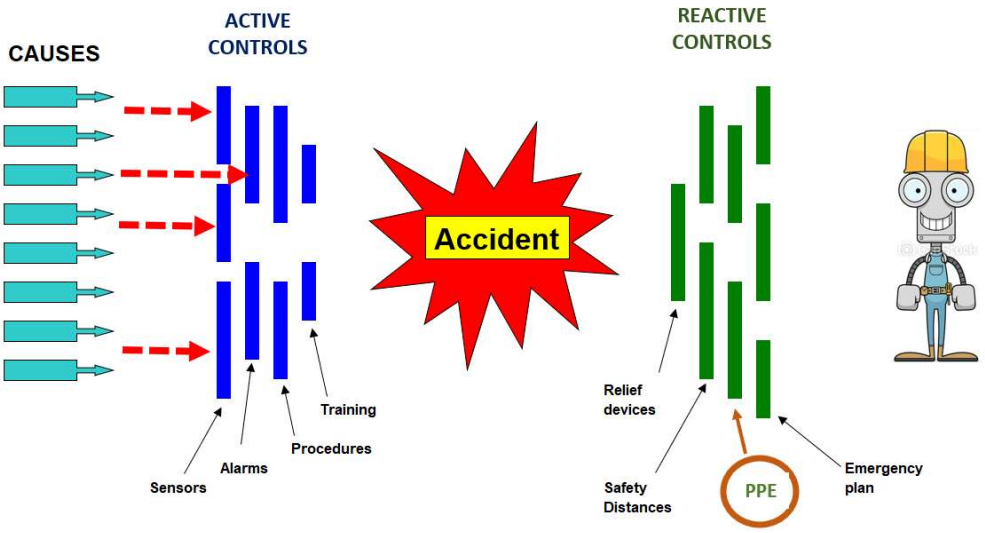
Note that the most effective action is associated with eliminating the hazard, which unfortunately is impractical in most cases. Thus, we begin to descend the hierarchy, arriving at the least effective action, which is the provision of personal protective equipment (PPE) to the employee.

Once the risks involved in an area/process have been identified, the various layers of protection can then be defined. These layers of protection can be divided into 2 groups, as follows:

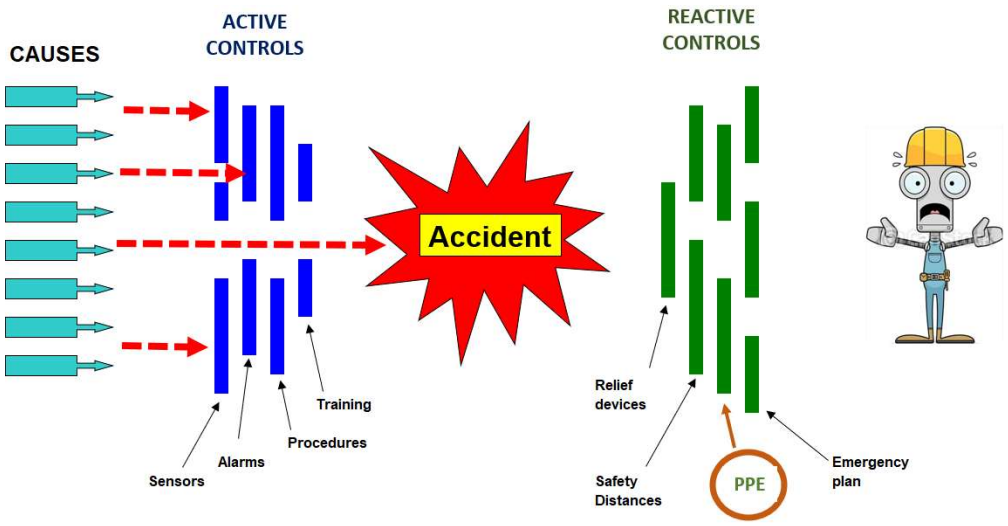
• **Active Protections:** these are the protections whose function is to prevent the occurrence of an undesirable event, associated with the hazards identified for each case. Thus, these protections act to prevent the occurrence of an accident, that is, they act **BEFORE** the accident occurs. Among the active protections we can mention sensors and alarms (to alert of any deviation from normality), operational procedures (which, if followed, lead to a controlled process), operational training, maintenance of equipment and instruments, etc.

When abnormalities occurs in the process, one or more of the active protections will act, allowing the operations to be put into a safe condition and preventing the possibility of an accident.

This protection model is shown in the following figures and is known as the “Swiss Cheese Model”, “Line of Fire”, “Bowtie” or “Reason Model”.

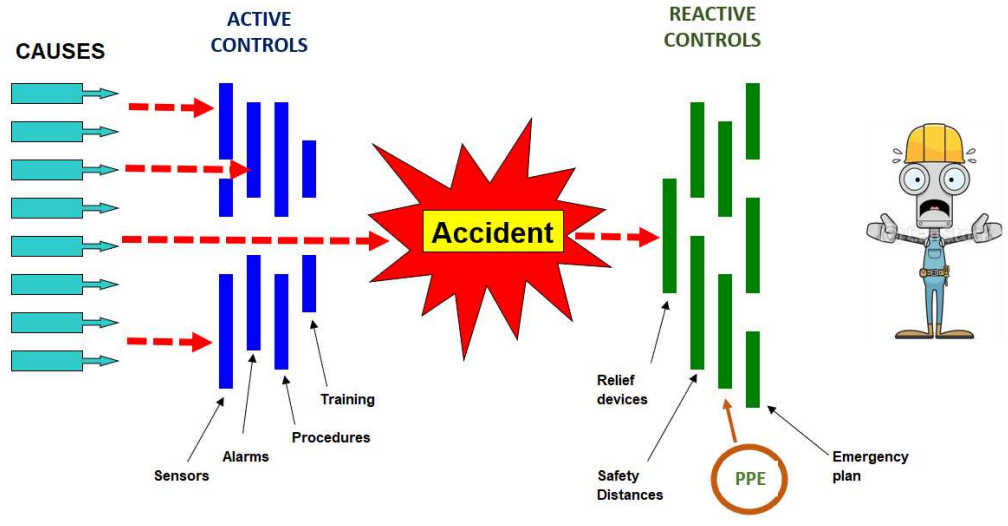


However, when several layers of active protection fail simultaneously or by "domino effect", then there is the possibility of an accident occurring:



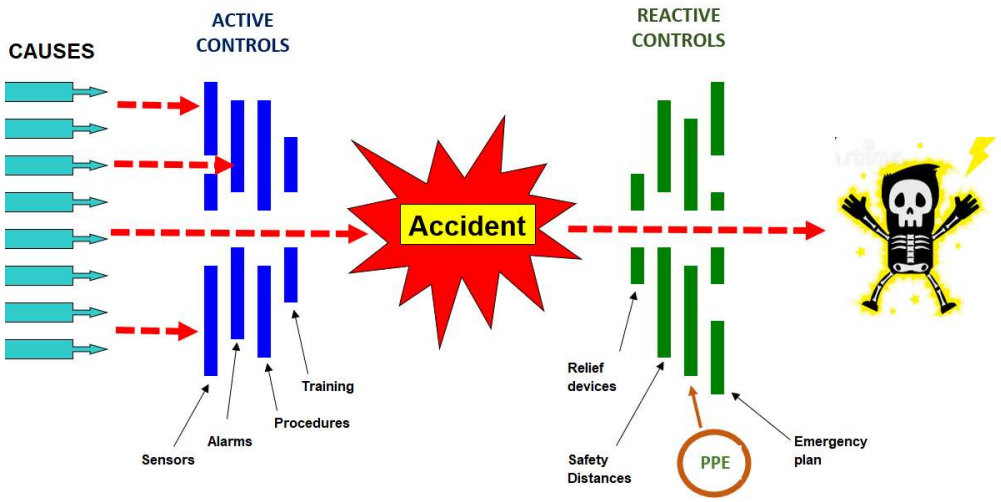
Once the accident has occurred, the next layers of protection to be activated are those designed to minimize the effects of the accident, called Reactive Protections, as described below.

• **Reactive Protections:** These are the protections whose function is to minimize the effects of an undesirable event, acting **AFTER** the occurrence of an accident. Among the reactive protections we can mention some relief devices (such as rupture discs), adoption of safety distances, activation of an emergency plan and PPE.



It is also possible that the various layers of reactive protection fail simultaneously or by a “domino effect”. In this case, the consequences of the accident will certainly be aggravated.

The efficiency and suitability of the reactive protection layers will determine the effect of the accident on people, facilities and the environment. Note that PPE is part of the reactive protection layer, i.e., it does not prevent accidents, but it can minimize or even prevent more serious injury to the employee. Everything will depend on the magnitude of the accident, the type of PPE available and its proper use.



In summary:

1) It is extremely important that companies make the identification and quantification of all risks associated to their processes/facilities, so the appropriate corrective actions can be prioritised.

2) Once the list of hazards and risks is available, the layers of protection necessary to achieve the level of risk determined by the organization and/or a government entity must be defined.

3) It is essential that all active and reactive layers of protection are subject to regular audits to ensure that they are always ready to action.

4) It is essential that any modification introduced to the process or facility is subject to a rigorous analysis in relation to the previously identified hazards and also in relation to the existing layers of protection.

5) Although the PPE does not prevent an accident from occurring, its correct use is fundamental to minimise the impact of the accident on the employee. Therefore, make sure that all employees have received the appropriate PPE for each job to be performed, and that they have been properly instructed on the correct use, cleaning and storage of the PPE.

6) Always seek for continuous safety improvement. It is essential that every deviation and/or abnormal event be duly recorded, analysed and that corrective actions are implemented. It is also important to share the lessons learned with other areas/plants of the company and, if possible, with other relevant entities/companies.

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The Author

***M.A. Almeida**, Chemical Engineer by UNICAMP, Risk Analysis Specialist by ICI Hazard Group – England and current member of the Technical Committee for Chemical Safety of CRQ/SP, is part of the group of professionals of **MATEC Soluções Corporativas Ltda.**, a Brazilian company specialized in projects for industrial installations and the use of best engineering practices, as well as personnel capacitation related to industrial safety.*