Guide for Risk Analysis and choice of Protective Measures

October 2002
PREAMBLE

This document is intended for company managers (users), designers and manufacturers of work equipment, in order to ensure a proper level of safety.

For this purpose, risk analysis\(^{(1)}\) must be performed. The present document aims at formalising this analysis and the choice of corresponding protection measures:

- This guide should help **company managers** acquire equipment ensuring the operators of a level of safety in line with the various foreseeable or planned uses. It should also facilitate risk analysis on existing equipment and facilities.

- It should allow **designers and manufacturers** to perform risk analysis on the basis of planned or foreseeable operations by the operators and thus identify and implement protection measures adapted to the hazardous situations.

- This guide can also be **applied in a great variety of areas** such as those mentioned in Chapter 4.

\(^{(1)}\) European Directive 98/37 of 22 June 1998, known as “machinery directive” states in Annex 1 that “The manufacturer is under an obligation to assess the hazards in order to identify all of those which apply to his machine; he must then design and construct it taking account of his assessment.” (This arrangement is transposed into French labour regulation: see section 1.1.2 of Annex 1 to Article R.233.84)
1. INTRODUCTION

As a result of technological progress, modern machinery is increasingly efficient, faster, smarter, more flexible and, furthermore, able to perform self-diagnosis.

Negotiations between customer and supplier therefore seldom take into account the people in the workplace. The future user, whether he be a production operator or a maintenance worker, is then forgotten, together with the risks to which he is exposed.

Increasing machinery complexity affects machine reliability, so that human intervention is still required to prevent detected malfunctions from causing lengthy production shutdowns or the manufacture of faulty products. Workers are therefore expected to be efficient, capable of performing their tasks immediately and responding quickly to malfunctions, whether the risks are visible or not, analysed or not, and estimated or not.

European directives on design of work equipment have two fundamental goals:

- design and manufacture of safe products;
- removal of technical barriers which could restrict the circulation of products.

While these directives offer designers and manufacturers access to a larger market, this means that they, in return, must offer safe products, meeting the essential requirements of these directives.

Regulations do not dictate how to proceed. The designer is free to conceive the means needed to meet occupational health and safety requirements. In practice, this freedom of action offered to the manufacturers is seldom used. Machinery for which a certificate of conformity has been provided and the CE marking affixed often entails risks that could have been detected and remedied by further analysis.

- How can future risks be controlled as of the design stage?
- How can collaboration between users and designers be facilitated?
- What means and tools can be employed so that a user wishing to invest in new machinery may be sure that his employees will not be exposed to risks of harm to their physical integrity or health?
- What information should be supplied to the manufacturer so that the new equipment, apart from purely legal aspects, may be truly adapted to man?

The proposed approach is based on analysis of operators’ tasks/activities and work situations.

While this approach is, of course, appropriate for special machinery and facilities, it can be used for less complex - or even standard - equipment or everyday work situations.

For simple, standard machinery, this approach should be adopted when the company’s specific use of the machinery and environment could generate hazardous situations that were not originally foreseen by the manufacturer for conventional applications.

Depending on the sector of activity and the complexity of equipment and facilities, the use of this method does not exclude compliance with codes, regulations and standards and the use of other
analysis methods.

Finally, it is not advisable to outsource this analysis work, since this could result in:

- possible loss of know-how,
- making the method inefficient and superficial,
- depriving oneself of progress which would be possible through increased knowledge and the proposal of new solutions.

The aim of the present document is to make users and designers aware that, with common sense and using simple means, workers' health and safety can be taken into account. Using the proposed analysis approach, focusing on workers, effective protective measures can be identified and then applied.

Various training sessions held at the CRAMIF have shown the practical nature of the approach discussed in this document, which is designed to be simple and understandable without aiming at being exhaustive or universal.

2. ANALYSIS METHOD

2.1. PRINCIPLE OF THE METHOD

The method proposes examining each operator task, step by step, in as detailed and concrete a manner as necessary. This will supplement the risk analysis performed by the designer on the equipment functions.

Such functional analysis often does not describe the operators' actions, whether they are in a normal operating situation or in incident recovery mode (maintenance, repair, etc.).

To make better allowance for workers, therefore, this method proposes supplementing functional analysis as of the design stage, with:

- the list of tasks;
- risk analysis;
- the operator's manual, ensuing from the previous two documents.

The first part of the method involves drawing up a list of tasks that the operator will have to perform, irrespective of the subsequent analysis (see example in Chapter 3).

Inevitably, the tasks actually performed are always somewhat different from the tasks stipulated. This difference can be considered as an operator response to the problems encountered in adapting capacities (staff + facilities, even well designed) to the work to be accomplished.

For greater efficiency and pragmatism, analysis of tasks and work situations should involve operator participation whenever possible. Otherwise, the designer will have to imagine and list them.

In all cases, thinking should allow for foreseeable abnormal tasks and situations.(2)

(2) Section 1.1.2 of Annex 1 to Article R 233.84 of Machinery Directive 98/37/EC
This analysis of tasks and work situations must be performed not only for the production stage but also for all other stages: adjustment, servicing, maintenance, cleaning, etc.

This description stage can be tedious. However, as a result:

- hazardous situations will not be overlooked;
- it will be possible to imagine prevention solutions other than the "first idea that springs to mind".

The second part involves performing risk analysis, looking for the various situations which could lead to harm by imagining the various scenarios resulting, in particular, from malfunctions, and by choosing protection measures.

The risk analysis will be formalised on the basis of a table proposed in Chapter 2.2.

In the hand left part of this table will be listed for each task, operation by operation, and for each hazard or danger, the risk elements which are essential to the analysis:

- the hazard or danger;
- the hazardous situation;
- the hazardous event and possible harm;
- and the probability and severity of the initial risk will be quantified.

In the right hand part of the table, the following decisions will be taken:

- Choose to act upon the risk element(s) enabling some of the most efficient protective measures to be taken,
- Choose the appropriate means of protection;
- Quantify the residual risk.

The higher the item in question in the list of risk components, the more effective must be the prevention measures chosen to reduce the risk (see Chapter 2.4).

At every stage of the project, the method allows the various players involved to express a viewpoint and to propose appropriate protective measures. It also enables optimisation of tasks and greatly facilitates production of operators' manuals and instructions.

The operator's manual shall detail all elementary operations, ensuring that they are in agreement with the analysis table. The drafting of this manual, in parallel to risk analysis, will be more efficient if it is performed from the very start of the design stage, at least in its principles and guidelines.

Once filled in, the analysis table is a summary of the various hazards and protective measures resulting from the risk analysis performed for each task.

It is presented hereafter with recommendations for use and the principal definitions. Examples of use are given in Chapter 3.
2.2. ANALYSIS TABLE: definitions; User informations

<table>
<thead>
<tr>
<th>TASK N°</th>
<th>name the task</th>
<th>FACILITY</th>
<th>SUPPLIER</th>
<th>PREMISES</th>
<th>SYSTEM</th>
</tr>
</thead>
</table>

- describe if possible the equipment and its function
- describe the task, and the means used
- add, a diagram or photograph if necessary

FACILITY:
SUPPLIER:
PREMISES:
SYSTEM:

<table>
<thead>
<tr>
<th>TASK N°</th>
<th>name the task</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MLP : Machinery Life Phase : Frequency :

- State the Machinery Life Phase
- State the frequency and duration of the task

<table>
<thead>
<tr>
<th>N°</th>
<th>Identification</th>
<th>Hazard or danger</th>
<th>Hazardous situation</th>
<th>Hazardous event possible harm</th>
<th>P S</th>
<th>Which element should be acted on ?</th>
<th>Means</th>
</tr>
</thead>
</table>

- List the successive stages of task performance with the various operator actions (or list the cycle phases for automatic operation)
- Also bear in mind waste

<table>
<thead>
<tr>
<th>P</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Risk : combination of the probability of occurrence of harm and the severity of that harm

Hazard or danger: Hazardous situation: Hazardous event possible harm

Elements of Risk

- Hazard:
- Potential source of harm
- Circumstance in which a person is exposed to at least one hazard.
- The exposure can immediately or over a period of time result in harm

Hazardous situation:
- Occurrence in which a hazardous situation results in harm
- Lésion physique ou atteinte à la santé

Hazardous event possible harm:
- Think about unexpected starting
- Think about the action of third parties who could operate on the equipment
- Think about “abnormal” operator action
- State the possible harm

PROTECTIVE MEASURES

- Describe the appropriate means for acting on the risk component(s) chosen alongside.

Means

<table>
<thead>
<tr>
<th>P</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

*DEFINITIONS: the terms and definitions used are extracted from international standards - see ISO guide 51, EN/ISO 12100 (EN 292) and EN/ISO 14121 (EN 1050)
2.3. RISK ANALYSIS

2.3.1. Principle of risk analysis

Risk analysis is performed in three stages:

1. Determination of the field of application (production, maintenance…) and the limits of the machinery.
2. Identification of hazards or dangers.
3. Risk estimation for each hazard or danger.

It forms part of the risk assessment approach described in Standard EN 1050. Figure 1 is a representation of the iterative process enabling safety to be achieved, in line with the concept of safe machinery.

![Diagram of risk analysis process]

Figure 1: The iterative process to achieve safety

* "Is safety adequate?" means, according to standard EN 292-1:1991:

- Has the required level of safety been reached?
- Is it certain that an equivalent level of safety cannot be obtained more easily?
- Is it certain that the measures taken:
  - do not excessively reduce the ability of the machine to perform its function?
  - do not generate new, unexpected hazards or problems?
- Are there solutions for all operating conditions, for all intervention procedures?
- Are the solutions compatible with each other?
- Are the operator’s working conditions not jeopardized by those solutions?
2.3.2 Conditions of occurrence of harm

Harm occurs only if the following three conditions are all met:

- A person is exposed to a hazard or danger (and is then in a hazardous situation);
- A hazardous event occurs, triggering the accident mechanism;
- There is no possibility of avoiding the harm.

A schematic representation is given in Figure 2.

An example of conditions leading to harm is attached in Annex B.
2.3.3. Risk estimation

Risk results from the combination of the probability of occurrence of harm and the severity of that harm.

The probability of harm is a function of:

- the frequency and duration of exposure to the hazard;
- the probability of occurrence of a hazardous event;
- the possibility of avoiding or limiting harm.

(see figure 3)

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**This definition is a quantitative approach to risk**

*Figure 3: Risk estimation as per Standard EN 1050:1996*

The hazard may result from the equipment (machine, environment, etc.) or personnel. These factors must therefore be taken into account in estimating the probability of occurrence.

Simple scales can be used to quantify the severity and probability of harm (see example proposed with the analysis table).
2.4. ELIMINATION OF HAZARD OR REDUCTION OF RISK

To eliminate (or reduce) risk, the condition(s) leading to harm should be treated as per Figure 2.

The higher in the following table is the aspect dealt with by the protective measure, the more effective said measure must be. Measures to eliminate rather than reduce the risk should be preferred.

![Figure 4: Eliminating or reducing Risk](image)

An example of conceivable measures to eliminate or reduce risks is attached in Annex C.
3. EXAMPLES OF APPLICATIONS

Example 1 : Water circuit of a steam boiler

Description :

The present example (non-exhaustive) is based on the list of tasks relating to the water circuit of a «boiler + steam consumer» assembly (see diagram below).

![Boiler + steam consumer assembly diagram]

**LISTE OF TASKS :**

**Feed water deaerator tank feed pump (Pb)**
1. Inspection visit
2. Stuffing box leakproofing check
3. Removal / refitting of pump
4. Removal / refitting of motor
5. Removal / refitting of motor-pump assembly

**Feed water deaerator tank (Ba)**
1. Inspection visit
2. Check on measuring instruments
3. Check on safety valves
4. Maintenance of safety valves
5. Maintenance of water circuit parts
6. Maintenance of steam circuit parts
7. Annual inspection of the interior
8. Annual cleaning of the interior

**Boiler feed pumps (A, B, C)**
1. Inspection visit
2. Test operation of standby pumps
3. Adjustment of stuffing box leakproofing
4. Removal / refitting of pump
5. Removal / refitting of motor
6. Removal / refitting of motor-pump assembly

**OPERATIONS (details of a task) :**

Each task should be broken down into operations during risk analysis. This breakdown is not necessary when drawing up the list of tasks, since it can appear directly on the analysis table.

In the following example we shall select Task No. 6: «Removal/refitting of the motor/pump assembly (A, B, C)».
Three pumps A, B and C feed water to the boiler (one in service: e.g. B, and two on standby: A and C). This operation is theoretically performed annually: removal of an entire pump system from its concrete block then fitting it back into place: e.g. A (motor-pump frame) for repair, without stopping the boiler (pump B stays in service). Removal to workshop on a self-propelled cart.

<table>
<thead>
<tr>
<th>OPERATION</th>
<th>ELEMENTS of RISK</th>
<th>PROTECTIVE MEASURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1</td>
<td>The operator(s) disconnect(s)/ reconnect(s) the electricity of the pump A motor</td>
<td>Rotation of the shaft of the pump A motor</td>
</tr>
<tr>
<td></td>
<td>220 V live conductor for pump A</td>
<td>Work close to a rotating part of pump A</td>
</tr>
<tr>
<td></td>
<td>Hot water at 105°C with a downstream pressure of 12 bar and an upstream pressure of 0.5 bar</td>
<td>Work on an electrical part of pump A</td>
</tr>
<tr>
<td></td>
<td>Hot parts of the pump</td>
<td>Contact with live conductor of pump A</td>
</tr>
<tr>
<td></td>
<td>Hot water splashing Burns</td>
<td>Contact with live conductor of pump A</td>
</tr>
<tr>
<td></td>
<td>Contact with hot parts Burns</td>
<td>Elimination of the hazard: Work close to pressurized hot water circuit</td>
</tr>
<tr>
<td>6.2</td>
<td>The operator(s) disconnect / reconnect pump A on the water circuit</td>
<td>Hot water at 105°C with a downstream pressure of 12 bar and an upstream pressure of 0.5 bar</td>
</tr>
<tr>
<td></td>
<td>Work close to pressurized hot water circuit</td>
<td>Work close to pressurized hot water circuit</td>
</tr>
<tr>
<td></td>
<td>Contact with hot parts Burns</td>
<td>Contact with hot parts Burns</td>
</tr>
<tr>
<td></td>
<td>Elimination of the hazardous event: hoist attached with secure access</td>
<td>Elimination of the hazardous event: hot water splashing Burns</td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
<td>6.3</td>
<td>The operator(s) install the hoist on the monorail above the assembly</td>
<td>Work at heights: Gravity</td>
</tr>
<tr>
<td></td>
<td>The operator attaches the hoist at a height of 4 metres</td>
<td>Loss of balance Person falling: Injury</td>
</tr>
<tr>
<td></td>
<td>Elimination of the hazardous event: hoist attached with secure access</td>
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</tr>
</tbody>
</table>

**MLP** = Machinery Life Phase
- Installation
- Commissioning
- Adjustment
- Maintenance
- Cleaning

**Frequency of the task**
- Permanent
- Daily
- Weekly
- Monthly
- Biannually
- Annually

**P** = Probability of occurrence of harm
- A: unlikely
- B: seldom
- C: occasional
- D: high

**S** = Maximum Severity of the possible harm
- 1: negligible
- 2: low
- 3: serious
- 4: fatal

**Means**
- Bold: inherent design measures or safeguarding
- Italic: complementary protective measures and information for use
<table>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>N°</strong></td>
<td>Hazard or danger</td>
<td>Hazardous situation</td>
</tr>
<tr>
<td>6.4</td>
<td>The operator(s) lift(s) and handle the whole pump unit A</td>
<td>Suspended 150 kg unit</td>
</tr>
<tr>
<td>6.5</td>
<td>All operations: the operator(s) work(s) on pump A or C near pump B in service</td>
<td>Rotation of the shaft of the pump B motor</td>
</tr>
</tbody>
</table>

**Means**

**Bold**: inherent design measures or safeguarding

**Italics**: complementary protective measures and information for use

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Example 2: Waste compactor (analysis of an operating procedure)

**TASK N° : Loading the hopper of a waste compactor**

<table>
<thead>
<tr>
<th>TASK N°</th>
<th>Identification</th>
<th>Hazard or danger</th>
<th>Hazardous situation</th>
<th>Hazardous event</th>
<th>P</th>
<th>S</th>
<th>Which element should be acted on?</th>
<th>Means</th>
<th>P</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>After attaching the empty bucket, the compactor is switched on for future use: the compactor is energised</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>The operator dumps waste in the hopper</td>
<td>220 V live compactor</td>
<td>The operator stands near a conducting metallic frame</td>
<td>Damaged connecting cable (rodents, humidity), energised by the frame</td>
<td>C</td>
<td>4</td>
<td>Reduced hazardous event. Remove the hazard from reach</td>
<td>- protect the cables with sleeves, shielding... - and use a leakproof equipment (IP55) - connect the frames to earth - and install a 30mA residual current sensitive device - and TN neutral condition or TT neutral condition</td>
<td>A</td>
<td>2</td>
</tr>
</tbody>
</table>

**Means**
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<th>Means</th>
<th>P S</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>The operator starts the compactor</td>
<td>Cyclic mechanical movement of waste pressing (Force, Speed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>The operator watches the compaction</td>
<td>Cyclic mechanical movement of waste pressing (force F, speed V)</td>
<td>The operator watches the compaction near the hopper</td>
<td>Non-compactable waste is in the hopper : random trajectory of the projected waste burning, puncturing, shock, etc.</td>
<td>Avoid the hazard, avoid loading products that are hazardous, harmful or non compactable, etc.</td>
<td>- train the operator to recognize whether products are compactable or not, and - organize the collection of non-compactable products - move the control box away from the hopper, and observe the hopper from a distance or indirectly (mirror) - set up obstacles to the projection of waste (hopper edges, hood)</td>
<td>B 4</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>If compacting is not taking place correctly, the operator may wish to intervene physically. During compacting, objects may cling to the vault and refuse to come down. Their descent have to be assisted at the press level.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4a</td>
<td>The operator rams the waste to obtain compacting</td>
<td>Cyclic mechanical movement of waste pressing</td>
<td>The operator pushes the upper part of the waste from the ground with a tool</td>
<td>Random movement of the tool when driven Shock, pinching of upper part of the body with the tool</td>
<td>Eliminate the operation Design a hopper capable of preventing or limiting vault clogging Avoid the hazard Eliminate the energy in motion Avoid the hazardous event Use a tool with a low bending resistance</td>
<td>Design vertical or asymmetric hopper edges to avoid bearing surfaces Switch off the power before inter-vening on clogged waste, isolation prior to the operation Design a tool which is risk-free tool in case of pinching</td>
<td>B 2</td>
<td></td>
</tr>
<tr>
<td>4b</td>
<td>Same as 4a above</td>
<td>Same as 4a above</td>
<td>The operator shoves the waste from the the bucket hanging bar (upper limbs and/or tool)</td>
<td>Loss of balance Fall into the hopper and risk of crushing or fall to the ground</td>
<td>Same as 4a above Avoid the hazardous situation Eliminate the possibility of climbing on the hanging bar</td>
<td>Set up the hopper so that its edge cannot be used as a hanging point and the bar as a bearing point</td>
<td>A 1</td>
<td></td>
</tr>
<tr>
<td>4c</td>
<td>Same as 4a above</td>
<td>Same as 4a above</td>
<td>From the compactor decking, the operator shoves the waste (lower limbs or upper limbs and/or tool)</td>
<td>Loss of balance Fall into the hopper and risk of crushing or fall on decking or ground</td>
<td>Same as 4a above Avoid the hazardous situation Eliminate the risk of falling into the hopper Eliminate the risk of falling to the ground from the decking</td>
<td>- raise the edges of the hopper, and - adapt the access (staircase, hand-rail), and - install a hand-rail on the decking of the compactor</td>
<td>B 1</td>
<td></td>
</tr>
</tbody>
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**Means**

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<table>
<thead>
<tr>
<th>PML = Machinery Life Phase</th>
</tr>
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<tbody>
<tr>
<td>Installation</td>
</tr>
<tr>
<td>Commissioning</td>
</tr>
<tr>
<td>Adjustment</td>
</tr>
<tr>
<td>Maintenance</td>
</tr>
<tr>
<td>Cleaning</td>
</tr>
<tr>
<td>Annually</td>
</tr>
</tbody>
</table>

**Frequency of the task**

- A : unlikely
- B : seldom
- C : occasional
- D : high

**Probability of occurrence of harm**

- 1 : negligible
- 2 : low
- 3 : serious
- 4 : fatal

**Maximum Severity of the possible harm**

- S = Maximum Severity of the possible harm

- P = Probability of occurrence of harm

### OPERATION

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</tr>
</thead>
<tbody>
<tr>
<td>Hazard or danger</td>
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### PROTECTIVE MEASURES

<table>
<thead>
<tr>
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<td></td>
</tr>
<tr>
<td>4b</td>
<td>Same as 4a above</td>
<td>Same as 4a above</td>
<td>The operator shoves the waste from the the bucket hanging bar (upper limbs and/or tool)</td>
<td>Loss of balance Fall into the hopper and risk of crushing or fall to the ground</td>
<td>Same as 4a above Avoid the hazardous situation Eliminate the possibility of climbing on the hanging bar</td>
<td>Set up the hopper so that its edge cannot be used as a hanging point and the bar as a bearing point</td>
<td>A 1</td>
<td></td>
</tr>
<tr>
<td>4c</td>
<td>Same as 4a above</td>
<td>Same as 4a above</td>
<td>From the compactor decking, the operator shoves the waste (lower limbs or upper limbs and/or tool)</td>
<td>Loss of balance Fall into the hopper and risk of crushing or fall on decking or ground</td>
<td>Same as 4a above Avoid the hazardous situation Eliminate the risk of falling into the hopper Eliminate the risk of falling to the ground from the decking</td>
<td>- raise the edges of the hopper, and - adapt the access (staircase, hand-rail), and - install a hand-rail on the decking of the compactor</td>
<td>B 1</td>
<td></td>
</tr>
<tr>
<td>N°</td>
<td>Identification</td>
<td>Hazard or danger</td>
<td>Hazardous situation</td>
<td>Hazardous event possible harm</td>
<td>P</td>
<td>S</td>
<td>Which element should be acted on?</td>
<td>Means</td>
</tr>
<tr>
<td>----</td>
<td>----------------</td>
<td>-----------------</td>
<td>--------------------</td>
<td>-------------------------------</td>
<td>---</td>
<td>---</td>
<td>-------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>5</td>
<td>The operator dumps waste into the compactor</td>
<td>Compactor energised</td>
<td>The operator wants to retrieve an object; he gets into the hopper</td>
<td>Unexpected starting crushing of all or part of the body</td>
<td>C</td>
<td>4</td>
<td>Avoid the hazard Eliminate the energy Avoid the hazardous situation Eliminate the energy if an access in the hazard zone is detected</td>
<td>Isolation before intervention Facilitate access to the hopper and detect access to avoid any starting (gate + opening and closing control) Due to possible failure to comply with the operating procedure and the severity of the possible harm, the second solution will be chosen (avoid the hazardous situation)</td>
</tr>
</tbody>
</table>

**TASK N° : Loading the hopper of a waste compactor**

<table>
<thead>
<tr>
<th>Machinery life phase</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>in use</td>
<td>Permanent</td>
</tr>
</tbody>
</table>

**OPERATION**

<table>
<thead>
<tr>
<th>N°</th>
<th>Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>The operator dumps waste into the compactor</td>
</tr>
</tbody>
</table>

**ELEMENTS of RISK**

<table>
<thead>
<tr>
<th>Hazard or danger</th>
<th>Hazardous situation</th>
<th>Hazardous event possible harm</th>
<th>P</th>
<th>S</th>
<th>Which element should be acted on?</th>
<th>Means</th>
<th>P</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compactor energised</td>
<td>The operator wants to retrieve an object; he gets into the hopper</td>
<td>Unexpected starting crushing of all or part of the body</td>
<td>C</td>
<td>4</td>
<td>Avoid the hazard Eliminate the energy Avoid the hazardous situation Eliminate the energy if an access in the hazard zone is detected</td>
<td>Isolation before intervention Facilitate access to the hopper and detect access to avoid any starting (gate + opening and closing control) Due to possible failure to comply with the operating procedure and the severity of the possible harm, the second solution will be chosen (avoid the hazardous situation)</td>
<td>A</td>
<td>2</td>
</tr>
</tbody>
</table>

**PROTECTIVE MEASURES**

<table>
<thead>
<tr>
<th>P</th>
<th>S</th>
<th>Which element should be acted on?</th>
<th>Means</th>
<th>P</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>negligible</td>
<td>Avoid the hazard Eliminate the energy Avoid the hazardous situation Eliminate the energy if an access in the hazard zone is detected</td>
<td>Isolation before intervention Facilitate access to the hopper and detect access to avoid any starting (gate + opening and closing control) Due to possible failure to comply with the operating procedure and the severity of the possible harm, the second solution will be chosen (avoid the hazardous situation)</td>
<td>A</td>
<td>2</td>
</tr>
</tbody>
</table>

**Means**

| Bold : inherent design measures or safeguarding |
| Italic : complementary protective measures and information for use |

---

**PML = Machinery Life Phase**

- Installation
- Commissioning
- Adjustment
- Maintenance
- Cleaning

**Frequency of the task**

- Permanent
- Daily
- Weekly
- Monthly
- Biannually
- Annually

**P = Probability of occurrence of harm**

- A : unlikely
- B : seldom
- C : occasional
- D : high

**S = Maximum Severity of the possible harm**

- 1 : negligible
- 2 : low
- 3 : serious
- 4 : fatal
4. FIELDS OF APPLICATION

As we have seen, the proposed approach is well adapted to the design and use of work equipment. However, being based on human activity, this approach can also be advantageously used in other fields such as:

- Design of working premises and buildings;
- Drawing up the dossier for subsequent intervention on the building;
- Building work;
- Drawing up the special plan for safety and health protection;
- Drawing up the asbestos removal plan;
- Provision of services (e.g. industrial cleaning);
- Drawing up the prevention plan in the case of work by an outside company;
- Drawing up the safety protocol for loading and unloading operations,
### TASK N°:

<table>
<thead>
<tr>
<th>OPERATION</th>
<th>ELEMENTS of RISK</th>
<th>PROTECTIVE MEASURES</th>
</tr>
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<td>N°</td>
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<td>Hazard or danger</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Machinery life phase:**
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**Means**
- Bold: inherent design measures or safeguarding
- Italics: complementary protective measures and information for use
Annex B: Example of conditions leading to harm

Person

Electrician operating in the electrical cabinet

+ Hazard:

230 V live conductor, bare

Hazardous situation

Electrician’s bare hands only a few inches away from the conductor

Hazardous event

The electrician is jostled by someone and/or the screwdriver slips and/or sudden hand movement occurs during wire stripping and/or the electrician rests on the conductor...

the electrician’s hand makes contact with the conductor

Possibility to avoid or limit the harm

There is no possibility to avoid or limit the harm

Harm

electrocution
### Annex C:
Example of conceivable measures for eliminating hazards or reducing risks

(Application to the example of Annex B)

<table>
<thead>
<tr>
<th>Person</th>
<th>remote monitoring or remote diagnostic...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazard</td>
<td>de-energised and isolate electrically</td>
</tr>
<tr>
<td></td>
<td>use a very low voltage for safety</td>
</tr>
<tr>
<td></td>
<td>isolate the wire...</td>
</tr>
<tr>
<td>Hazardous situation</td>
<td>move conductor away from the work area...</td>
</tr>
<tr>
<td></td>
<td>place a separating screen between the conductor and the work area</td>
</tr>
<tr>
<td>Hazardous event</td>
<td>isolate the work area</td>
</tr>
<tr>
<td></td>
<td>use a insulated screwdriver</td>
</tr>
<tr>
<td></td>
<td>use a wire stripping tool, to avoid sudden hand movements...</td>
</tr>
<tr>
<td>Possibility to avoid or limit the harm</td>
<td>install a residual current sensitive device</td>
</tr>
<tr>
<td></td>
<td>work with insulating gloves</td>
</tr>
<tr>
<td></td>
<td>install an emergency stoppage device...</td>
</tr>
</tbody>
</table>
Annex D : Bibliography

Standards

EN 292 (1991)  Safety of machinery – Basic concepts - general principles for design

EN 1050 (1996) Safety of machinery – Principles for risk assessment

INRS publications (Institut National de Recherche et de Sécurité)

ED 807  Sécurité des machines et des équipements de travail
        Moyens de protection contre les risques mécaniques

ED 1368  Facteurs humains de la fiabilité et de la sécurité des systèmes complexes

ED 1503  Analyse du poste de travail et démarche ergonomique

ED 1520  Concevoir une machine sûre

ED 1521  Maintenance et maîtrise du risque

Miscellaneous

La sûreté des machines et installations automatisées. Published by : Apave – Télémécanique

Guide d'intervention sur les machines, sur les équipements de travail. Edition : CRAMIF : Note technique n° 11

La réglementation communautaire pour les machines – Commentaires sur les directives 89/392/CEE et 91/368/CEE. Edition : Office des publications officielles des communautés européennes.
Notes...
Notes...
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