# Chemical risk assessment

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**Abstract**

**The Employer must provide the assessment of the chemical risk in the activities involve for workers the risk of exposure to chemical agents. The evaluation reported in this paper is an estimated assessment based on the guidelines for chemical risk assessment published by the Piedmont Region. Were evaluated the level of exposure, the gravity intrinsic potential of the chemical agent and the duration of the exposure. The product of the three counters deriving from the evaluation of the respective risk factors leads to a synthetic RISK INDEX, expressed in a numerical scale varying between 0 and 100, which is empirically segmented into such distributed risk classes. The chemical risk can be irrelevant or not-irrelevant; if the risk to workers' health proves to be "not irrelevant" there is an obligation on the part of the Employer to arrange for health surveillance, as well as other measures envisaged by articles 225, 226, 229 and 230 of Legislative Decree 81/08. The risk assessment must be done subdividing worker in homogeneous groups.**

*KEY WORDS: assessment, chemical risk, chemical substance, work, worker.*

## Introduction

In application of the Legislative Decree 81/08 (1), Title IX Chapter I, the Employer in collaboration with the Prevention and Protection Service, must provide the assessment of the chemical risk in the activities of the Company that involve for workers the risk of exposure to chemical agents.
By way of example, the chemical risk assessment of a company in which workers use chemicals in the company production cycle is reported.
The evaluation reported in this paper is an estimated assessment that is not based on monitoring data acquired through field sampling, but on the dangerousness characteristics of each substance used, on the methods of use and on the exposure times, as expected from Title IX of Legislative Decree 81/08 (1).
The risk assessment document for workers exposed to chemical agents:

– Constitutes an integral part of the risk assessment document prepared pursuant to Legislative Decree 81/08 art. 28;
– Is subject to periodic updating where there are significant changes that could have made it exceeded or when the results of medical surveillance show the need for it.

The risk assessment was carried out by the Employer who availed himself of the collaboration of the Head of the prevention and protection service, the Occupational Physician and external consultants (where present).
In particular, as amply illustrated below, the application model proposed by the guidelines for chemical risk assessment published by the Piedmont Region was used. The choice of this method was suggested by two basic considerations:

1. The need to reach results that are based on a nationally recognized evaluation algorithm, also by the authorities in charge of controls;
2. The need for a structured method with indexes that would allow to manage in a more immediate way the considerable quantity of data necessary for the evaluation, guaranteeing at the same time the repeatability and reliability of the results achieved.

## Legislation references

The assessment of risks to the safety and health of workers is carried out in relation to the requirements

of Legislative Decree 81/08; this document refers to the assessment of exposure to hazardous chemical agents in the workplace, in compliance with the requirements of art. 223 of Legislative Decree 81/08 (1). Legislative Decree 81/08 requires the Employer to carry out:
Preliminary assessment of workers' exposure risks;
To update it periodically based on substantial changes in the meantime;
To take based on the results, all the prevention and protection measures, both collective and individual, necessary to minimize the risk.

The risk assessment must contain information relating to:
- nature, hazard and quantity characteristics of the chemical substances present;
- methods of use, prevention and protection measures implemented;
- extent of exposure, understood as the number of workers potentially exposed, type, duration and frequency of exposure;
- effects of the security measures put in place;
- exposure limit values and biological values of the agent;
- results of health checks and any environmental monitoring carried out;
- any conclusions drawn from the health surveillance actions already undertaken;
- any measures deemed appropriate to implement, based on the results of the risk assessment.

Title IX Chapter I applies to all activities in which dangerous substances and/or preparations are present and in particular in all the possible work phases listed below:
- Production;
- Manipulation;
- Storage;
- Transport or disposal;
- Waste treatment.

Chemical agents are those classified or classifiable as:
- Dangerous substances pursuant to Legislative Decree 3 February 1997, n. 52, and subsequent amendments (Legislative Decree 28 July 2008, n. 145) (2);
- Dangerous mixtures pursuant to Legislative Decree 14 March 2003, n. 65, and subsequent amendments (CE n. 1272/2008) (3);
- Agents who, although not classifiable as dangerous, may pose a risk to the safety and health of workers due to their chemical-physical, chemical or toxicological properties and the way in which they are used or present in the workplace;
- Chemical agents which are assigned an occupational exposure limit value.

It is necessary to refer to substances and preparations:
- Explosive;
- Oxidizing;
- Extremely flammable;
- Highly flammable;
- Flammable;
- Very toxic;
- Toxic;
- Harmful;
- Corrosive;
- Irritants;
- Sensitizers;
- Carcinogenic;
- Mutagenic;
- Toxic for the reproductive cycle.

On the other hand, substances that are only dangerous for the environment are excluded from the scope of application of Legislative Decree 81/08 (Article 222 paragraph 1 letter b) (1).
The classification can be identified by the risk phrases (R phrases) on the safety data sheets.

**Analysis of activities carried out and tasks**

From the risk analysis carried out for all the offices of Company X, it turned out that the realities in which dangerous substances are used are those present in a site. Through inspections and interviews with the managers, the data and information necessary for assessing the risk of exposure to dangerous chemical agents and identifying the prevention and protection measures adopted and to be adopted were acquired.

*1. Description of workplaces and activities carried out*
The following departments are currently present in the building under assessment:
– *Immunochimica Department*, divided into two sections: immunochemistry section and neonatal screening section;
– *Genetic Analysis Department*, divided into two sections: genetics section and molecular biology section;
– *Department of Hematology*;
– *Withdrawal and Acceptance Room*;
– *Department of Clinical Chemistry and Microbiology;*
– *Clinics.*

In all departments there are closed circuit equipment, chemical and biological hoods, counters, equipment and workstations; in the storage/warehouse rooms within some departments there are collective use equipment such as refrigerators, autoclaves, and various types of instrumentation.

*2. Identification of the tasks and homogeneous groups exposed*
The analysis of the tasks was carried out consistently with the approach for Homogeneous Workers Groups introduced in the Risk Assessment Document or groups of workers who, by carrying out activities characterized by the same specific risks and by the same homogeneous areas, are exposed to the same Factors of Risk.

In the specific case, in the departments described above, the following homogeneous groups potentially exposed to chemical risk are present:
– Laboratory workers;
– Nurses;
– Doctors.

**Methodologies used for the assessment of chemical risk**

This document uses an application model for the assessment of chemical risk pursuant to art. 223 of Legislative Decree 81/08, with the aim of reaching an estimated level of risk based on the substances used.

***1. Risk index (IR) and risk level (LdR)***

For the purposes of the risk assessment process, it is believed that the existence of a "risk" derives from the set of three factors:
1. The *Level of Exposure* which corresponds a factor or Index of Exposure IE;
2. The *Gravity* (or negative *Quality*) intrinsic potential of the chemical agent, which corresponds a factor or Index of Gravity IG;
3. The *Duration* of the actual exposure to the chemical agent, which corresponds a factor or Index of Duration ID.

The three factors/indices contribute to the definition of the Risk Index (IR) and to the relative level of risk according to the following expression:
LdR => IR = IE x IG x ID
The Duration Index and the Exposure Index combine to define the amount of actual exposure of the worker to the chemical agent.
The risk assessment is therefore structured through a sequence that envisages a multiplicative process between the three factors defined above.
The product of the three counters deriving from the evaluation of the respective risk factors leads to a synthetic *Risk Index*, expressed in a numerical scale varying between 0 and 100, which is empirically segmented into such distributed risk classes (Table 1).
It is believed that the existence of IRRELEVANT risk to workers' health can be affirmed, pursuant to art. 224 Paragraph 2 of Legislative Decree 81/08, only when the risk indicator is in the first class, with a value between 1 and 10.
When the risk index is placed in the remaining classes (modest, medium, high, very high) then there is talk of the existence of a NON-IRRELEVANT risk for the health of workers.
In this case it is necessary to proceed to a deepening of the evaluation by carrying out environmental measures comparable with the limit values for exposure to the substance.
The following paragraphs describe the criteria which determine the three factors.

***2. Determination of risk factors***

In order to carry out the chemical risk assessment, first of all we identified the substances used by Company X workers, which, due to their toxicological properties, timing and methods of use, can determine a significant level of risk.
Substances that are defined for their effects are taken into consideration:
– *Corrosive*: in contact with living tissues they can exert a destructive action on them;
– *Irritants*: although not corrosive, it can produce an inflammatory reaction upon immediate, prolonged or repeated contact with the skin and mucous membranes;
– *Harmful*: for inhalation, ingestion or skin penetration, it may involve risks of limited gravity;
– *Toxic*: may cause serious, acute or chronic risks and even death if inhaled, swallowed or if it penetrates the skin.

Chemical agents that have no harmful effects on humans or that are used in minimum quantities (of the order of a few weekly or monthly milligrams) have been excluded.
These substances can be associated with a negligible level of risk.
It should also be noted that these instructions do not apply to risks arising from exposure to substances known to be carcinogenic or mutagenic.
These substances, which are identified by the follow-

**Table 1 - Classification of the level of risk based on the Risk Indicator.**

| RISK INDEX IR | | | | |
|---|---|---|---|---|
| **IR** | **Risk Class** | **Measures of protection and prevention** | **Health Risk Class according to Legislative Decree 81/08** | **Safety Risk Class according to Legislative Decree 81/08** |
| 1-10 | Low | Not necessary | Irrelevant | Low |
| 11-25 | Modest | Appropriate in the medium term | Not irrelevant | Not low |
| 26-50 | Medium | Suitable in the short term/ necessary in the medium term | | |
| 51-75 | High | Needed in the short term | | |
| 76-100 | | Very high | Urgent | |

ing risk phrases R45 (can cause cancer), R46 (mutagen: can cause hereditary genetic alterations) and R49 (can cause cancer by inhalation) are regulated by specific legislation (Legislative Decree 81/08 Title IX Chapter II), do not fall, therefore, in the field of the present chemical risk assessment.

*2.1 Gravity Index (IG)*
For the determination of the Severity Index the proposed method is based on the criteria of the EEC classification of Substances and Dangerous Preparations, according to Directive 67/548/EC and subsequent adaptations to technical progress (Regulation (EC) No. 1272/20083) (4).
Starting from this classification, it is possible to determine the severity class according to the risk phrase associated with the substance.

Substances classified with risk phrases are associated with severity class 1 (extent of mild damage: reversible effects):
- R22 harmful if swallowed
- R36 irritating to the eyes
- R37 irritating to the respiratory tract
- R38 irritating to the skin
- R36/37 irritating to eyes and respiratory tract
- R36/38 irritating to eyes and skin
- R36/37/38 irritating to eyes, respiratory system and skin
- R37/38 irritating to respiratory tract and skin
- R66 repeated exposure may cause skin dryness or cracking.

Substances classified as risk phrases with severity class 2 (extent of moderate damage: potentially irreversible effects):
- R20 harmful by inhalation
- R21 harmful in contact with skin
- R20/21 harmful by inhalation and skin contact
- R20/22 harmful by inhalation and if swallowed
- R20/21/22 harmful by inhalation, contact with skin and if swallowed
- R21/22 harmful in contact with skin and if swallowed
- R25 toxic by ingestion
- R34 causes burns
- R35 causes severe burns
- R41 risk of serious eye damage
- R43 may cause sensitization by skin contact
- R65 may cause lung damage if swallowed
- R67 inhalation of vapors may cause drowsiness and dizziness.

Substances classified with risk phrases under the severity class 3 (average damage: irreversible effects):
- R23 toxic by inhalation
- R24 toxic in contact with skin
- R23/24 toxic by inhalation and skin contact
- R23/25 toxic by inhalation and if swallowed
- R23/24/25 toxic by inhalation, contact with skin and if swallowed
- R24/25 toxic in contact with skin and if swallowed
- R28 very toxic if swallowed
- R42 may cause sensitization by inhalation
- R42/43 may cause sensitization by inhalation and skin contact.

Substances classified with risk phrases under severity class 4 (extent of high damage: serious irreversible effects):
- R26 very toxic by inhalation
- R26/27 Very toxic by inhalation and skin contact
- R26/28 Very toxic by inhalation and if swallowed
- R26/27/28 Very toxic by inhalation, in contact with skin and if swallowed.
- R27 very toxic in contact with skin
- R27/28 Very toxic in contact with skin and if swallowed
- R42 may cause sensitization by inhalation
- R62 possible risk of impaired fertility
- R63 possible risk of harm to the unborn child
- R64 possible risk for breastfed babies
- R68 possibility of irreversible effects
- R68/20 Harmful: possibility of irreversible effects through inhalation
- R68/21 Harmful: possibility of irreversible effects in contact with the skin
- R68/22 Harmful: possibility of irreversible effects if swallowed
- R68/20/21 Harmful: possible risk of irreversible effects through inhalation and in contact with skin
- R68/20/22 Harmful: possible risk of irreversible effects through inhalation and ingestion
- R68/21/22 Harmful: possibility of irreversible effects in contact with skin and if swallowed
- R68/20/21/22 Harmful: possible risk of irreversible effects through inhalation, in contact with skin and if swallowed.

Substances classified as very toxic but with a risk phrase R39 (danger of very serious irreversible effects) or as toxic but with risk phrases are: class 5 (size of very high damage: possibly lethal effects)
- R33 danger of cumulative effects
- R39 danger of very serious irreversible effects
- R39/23 Toxic: danger of very serious irreversible effects through inhalation
- R39/24 Toxic: danger of very serious irreversible effects in contact with skin
- R39/25 Toxic: danger of very serious irreversible effects if swallowed
- R39/23/24 Toxic: danger of very serious irreversible effects through inhalation and in contact with skin
- R39/23/25 Toxic: danger of very serious irreversible effects through inhalation and ingestion
- R39/24/25 Toxic: danger of very serious irreversible effects in contact with skin and if swallowed
- R39/23/24/25 Toxic: danger of very serious irreversible effects through inhalation, contact with

skin and if swallowed
- R39/26 Very toxic: danger of very serious irreversible effects through inhalation
- R39/27 Very toxic: danger of very serious irreversible effects in contact with skin
- R39/28 Very toxic: danger of very serious irreversible effects if swallowed
- R39/26/27 Very toxic: danger of very serious irreversible effects through inhalation and in contact with skin
- R39/26/28 Very toxic: danger of very serious irreversible effects through inhalation and ingestion
- R39/27/28 Very toxic: danger of very serious irreversible effects in contact with skin and if swallowed
- R39/26/27/28 Very toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed
- R40 (possibility of carcinogenic effects - insufficient tests)
- R48 (danger of serious damage to health in the event of prolonged exposure)
- R48/20 Harmful: danger of serious damage to health by prolonged exposure through inhalation
- R48/21 Harmful: danger of serious damage to health by prolonged exposure to skin
- R48/22 Harmful: danger of serious damage to health by prolonged exposure if swallowed
- R48/20/21 Harmful: danger of serious damage to health by prolonged exposure through inhalation and in contact with skin
- R48/20/22 Harmful: danger of serious damage to health by prolonged exposure through inhalation and if swallowed
- R48/21/22 Harmful: danger of serious damage to health by prolonged exposure in contact with skin and if swallowed
- R48/20/21/22 Harmful: danger of serious damage to health by prolonged exposure through inhalation, in contact with skin and if swallowed
- R48/23 Toxic: danger of serious damage to health by prolonged exposure through inhalation
- R48/24 Toxic: danger of serious damage to health by prolonged exposure in contact with skin
- R48/25 Toxic: danger of serious damage to health by prolonged exposure if swallowed
- R48/23/24 Toxic: danger of serious damage to health by prolonged exposure through inhalation and in contact with skin
- R48/23/ 25 Toxic: danger of serious damage to health by prolonged exposure through inhalation and ingestion
- R48/24/25 Toxic: danger of serious damage to health by prolonged exposure in contact with skin and if swallowed
- R48/23/24/25 Toxic: danger of serious damage to health by prolonged exposure through inhalation, in contact with skin and if swallowed
- R60 may reduce fertility
- R61 can harm unborn children.

As can be seen, the danger by exclusive digestive tract is normally attributed to a lower gravity class than that due to a similar inhalation or skin contact hazard, in consideration of the substantial non-relevance, in the occupational context, of absorption by this way, unless the basic hygiene rules are respected.
In the presence of more than one risk phrase, the highest Gravity Factor is used, relative to the risk phrases associated with the substance under examination. Below is a summary table of the gravity factor and the relative index (Table 2).

*2.2 Index of Duration ID*
The value to be attributed to this factor depends on the exposure time calculated on a weekly basis according to the criterion shown in the following table (Table 3).

*2.3 Exposure Index (IE)*
As already mentioned, in the first phase of application of the method, in the absence of environmental data, exposure to a specific substance is estimated based on the quantity and method of use.
The evaluation factor correlated to the level of exposure is that which generally involves a more articulated analysis, since it must take into consideration quantity of use/exposure, environmental factors, technical protection, etc.
The IE exposure index is a factor that is attributed a value ranging from 0.5 to 5, and can be derived from

**Table 2 - Severity Index.**

| INDEX OF GRAVITY IG | | |
|---|---|---|
| **Assigned value** | **Gravity** | **Effects** |
| 0 | Absent | Absence of foreseeable effects |
| 1 | Mild | Reversible effects |
| 2 | Modest | Potentially irreversible effects |
| 3 | Medium | Definitely irreversible effects |
| 4 | High | Serious irreversible effects |
| 5 | Very high | Possibly lethal effects |

**Table 3 - Duration Index.**

| INDEX OF DURATION ID | | | |
|---|---|---|---|
| **Assigned value** | **Frequency of use** | **Duration** | |
| 0.5 | Rarely | A | <1% weekly working time |
| 1 | Occasionally | B | 1-10% weekly working time |
| 2 | Frequently | C | 11-25% weekly working time |
| 3 | Usually | D | 26-50% weekly working time |
| 4 | Always | E | 51-100% weekly working time |

technical considerations, so we will talk about an estimated probability (PS). On the basis of the quantities of substance used per week, per employee, the Exposure Index is obtained according to the following scheme (Table 4).
It being understood that the limit of this factor can be a maximum of 5 and that applying the corrections listed below can theoretically be negative, it is expected that the weighting value is never considered to be less than 0.5.
The assessment of the estimated risk involves a correction, based on the physical state of the substance, the type of plant, the type of process, the existence of technical protection devices and the possibility of skin contact.
The possible corrections to be made are shown in the following tables (Tables 5-9).
In the case of simultaneous presence of several substances/compounds with different physical state, a correction factor equal to +1 is used due to "non-evaluability in detail".

## Risk assessment

The analysis of the tasks of homogeneous groups made it possible to identify workers potentially exposed to chemical risk and who will be the subject of this assessment.

They are health workers operating in the departments of:
- Genetics;
- Immunochemistry;
- Coagulation and hematology;
- Clinical chemistry and microbiology.

As for doctors and nurses in the clinic, given the operating procedures of the outpatient visits and the quantities of substances used, it is irrelevant that the risk from exposure to chemicals can be concluded. In any case, they will be periodically subjected to the health surveillance protocol and when the current conditions change, a thorough investigation will be carried out.
For all the other homogeneous groups present in the site, given the absence of significant contact routes with dangerous chemical agents, the risk can be considered irrelevant without the need for further investigation.
Below is a description of the stages of the assessment of the estimated risk.

### *1. Initial analysis*

From the initial analysis it was possible to identify substances/preparations that are not classified as hazardous to health. These substances have been excluded from the subsequent evaluation phase because the risk associated with non-hazardous substances/preparations can be considered irrelevant.
These substances/preparations are shown below, di-

**Table 4 - Exposure Index.**

| INDEX OF EXPOSURE IE | | | | |
|---|---|---|---|---|
| **IE** | **kg or liters used per week per employee** | | **exposure** | **Operating condition** |
| 0.5 | A | < 0.1 | Negligible | Highly protective |
| 1 | B | 0,1-1 | Mild | Highly protective |
| 2 | C | 1-10 | Poor | Protective |
| 3 | D | 10-100 | Medium | Not very protective |
| 4 | E | 100-1000 | High | Very little protection |
| 5 | F | > 1000 | Very high | Not protective |

**Table 5 - Corrections to be made based on the physical state of the substance.**

| PHYSICAL STATE OF THE SUBSTANCE | | CORRECTION |
|---|---|---|
| **Gas** | +1 | |
| **Liquid** | Boiling temperature > 150 °C | 0 |
| | Boiling temperature 50 - 150 °C | +0,5 |
| | Boiling temperature < 50 °C | +1 |
| **Solid** | Not breathable (granules or flakes) | 0 |
| | Breathable | +1 |

**Table 6 - Corrections to be made depending on the type of system.**

| TYPE OF PLANT | CORRECTION |
|---|---|
| Closed and sealed cycle | -3 |
| Closed cycle but with manual loading and unloading | -2 |
| Closed cycle but with periodic and limited manual interventions | -2 |
| Closed cycle but with manual loading/unloading and with periodic and limited manual interventions (e.g. sample collection | -1 |
| Process with effectively remotized operators | -1 |
| Manual | 0 |
| Manual in inadequate operating conditions | +1 |

**Table 7 - Corrections to be made based on the type of process.**

| PROCESS TYPE | CORRECTION |
|---|---|
| In pressure | +0,5 |
| With thermal energy supply in the process | + 0,5 |
| With mechanical energy input in the process | +0,5 |

**Table 8 - Corrections to be made based on the existence of the Technical Protection Devices.**

| PROTECTION DEVICES | CORRECTION |
|---|---|
| With scheduled maintenance plans | -1 |
| Structurally suitable but without planned maintenance plans | - 0,5 |

**Table 9 - Corrections to be made based on the possibility of skin contact.**

| CUTANEOUS CONTACT | CORRECTION |
|---|---|
| Possibility of skin contact | + 1 |
| Absence of possibility of skin contact | 0 |

vided according to the departments in which they are used:

- Immunochemistry Department:
  - Acetone for ACS, ISO analysis
  - Absolute ethyl alcohol for ISO analysis
  - L-Asparagine monohydrate for biochemistry
  - Beta-Nicotinamide adenine dinucleotide phosphate diso.salt

- D (+) - Galactose puriss. DAC, Ph Ned
- Glycerin for analysis
- D (+) - Glucose monohydrate DAB, Ph Eur, BP, USP
- Magnesium sulphate heptahydrate for analysis
- Potassium monobasic anhydrous phosphate Suprapur
- Sodium chloride for ACS, ISO analysis
- Anhydrous sodium sulfate for ACS, ISO analysis
- 2,3,5-Trienyl tetrazole hydrochloride for the control of seed germination capacity and for microbiology
• Genetics Department:
- 2-Propanol p.a. ACS, ISO
- Coagulation and Hematology Department:
- Cell-Dyn WBC Lyse Reagent
- Cell-Dyn 3200 Diluent/Sheath
- Cell-Dyn 22 Tri-Level Control High
- Cell-Dyn 22 Tri-Level Control Normal
- Cell-Dyn 22 Tri-Level Control Low
• Department of Clinical Chemistry and Microbiology:
- Ethyl alcohol
- Monobasic sodium phosphate dihydrate puriss. DAB, Ph Eur, BP, USP
- Propyl alcohol iso for ACS, ISO analysis
- Viscose paraffin DAB, Ph Eur, BP, USP
- Ethyl ether for ACS analysis
- Sodium chloride for ACS, ISO analysis
- Acetone for ACS, ISO analysisFor these substances there is no risk of exposure as they are not dangerous.

***2. Evaluation of the estimated risk***

Once identified the substances that can lead to significant levels of chemical risk, we proceeded to assess the estimated risk for each chemical agent, taking into account the information in our possession, namely:

- Toxicity of the substance,
- Amount of substance used,
- Method of use,
- Duration of exposure.

This allows a standardized evaluation approach even in the absence of measurements of the environmental data and simplifies, at least in a first phase, the evaluation (estimated risk).

If an initial assessment of the estimated risk shows results that do not allow an immediate application of the concept of “irrelevant risk” for health, pursuant to art. 224 paragraph 2 of Legislative Decree 81/08, it will be necessary to verify the possibility of proceeding with environmental measures from which the extent of the risk itself can be derived by algorithm.

A table shows the acquired data relating to all the substances in use at the headquarters of Company X and the calculations made for the assessment of the estimated risk. In particular:

- Area/department of use (e.g. Genetics department, microbiology, etc.)
- Homogeneous group
- Name of the substance or preparation
- Risk phrases (from which the gravity index was derived)
- Time of use of the substance (from which the durability index was derived)
- Quantity of the substance used by each worker per week (from which the exposure index was obtained)
- Correction factors (e.g. Status of the substance, type of system, technical protection devices, etc.)
- Risk index
- Level of risk
- Specific measures.

*2.1 Severity Index*

As previously reported, the Severity Index is directly linked to the Risk Phrase associated with the substance. For substances in use at the site being evaluated, values of the gravity factor ranging from 1 to 5 were obtained. It can therefore be seen that there are both substances with possible reversible effects and slight entity of a possible damage and substances with a high degree of damage.

These include, for example, some test kits containing chloroform, formamide, acrylamide.

For the purposes of assessing the estimated risk, however, it is important to combine the Severity Factor with the other two factors (Duration and Probability Estimated) so that a substance with Severity Factor 5 is not necessarily associated with a significant level of risk.

*2.2 Duration Index*

The Duration Index is determined based on the actual time of use of each substance.

In the case in question, given the variety of substances used and the analyzes carried out, it is difficult to establish the duration factor for each substance. For this reason it was decided to operate in precautionary conditions, considering, for each substance or preparation, a time of use equal to 26-50% of the weekly working time.

*2.3 Exposure Index*

The Exposure Index depends on the quantities used weekly. For the substances in use at the site in question we have chosen to perform a reverse procedure, i.e. we calculated, for each substance, the maximum quantity that can be used weekly by an employee so that there is no risk of exposure to his health.

For each substance, the physical state, the methods of use and the technical protection devices in use were taken into account and the relative corrective factors were applied. In this way the correct exposure level was sometimes zero, therefore, as already explained above, the minimum admissible value for the actual correct exposure index, which is equal to 0.5, was considered.

For example, for activities in the laboratories, semi-confined processes have been considered, that is the use of analysis lines in which the contact between the processed substances and the operator cannot be excluded a priori.

Regarding the possibility of skin contact, this was considered for those substances/preparations for which, based on classification or toxicological evidence, the possibility of cutaneous absorption or significant effects on the skin was found (risk phrases R21, R24, R27, R34, R35, R38, R43, R66).
Finally, for most of the substances, a quantity limit of use equal to 10 kg or 10 liters per week per employee was found. Exceptions are some substances with an index of severity equal to 5, for which a quantity of use greater than 1 kg or 1 liter per week per employee is not recommended, such as chloroform, ethidium bromide, acrylamide, papanicolaou solution, etc.

## Analysis of the results

*1. Presentation of results*
The summary table shows the Risk Indicator calculated for each substance and the consequent Risk Level. In addition to information on the final result, the values of the individual indices and the values assigned to the parameters relating to the methods of use of the substance for the correction of the estimated exposure probability are shown.
In the specific case, no risk indexes greater than 10 were obtained despite the fact that for some substances the gravity factor assumes a higher value. This is due to several factors that were taken into consideration during this assessment and that lower the risk index:

- Low quantities of substances used
- Low exposure times
- Use of technical protection devices that prevent skin contact or inhalation of the substance
- Physical state of chemical substances or compounds
- Type of use
- Use of products as they are without adding thermal energy or mechanical energy.

For all substances or preparations in use, as the risk index is less than 10, the level of risk to the health of the worker is *irrelevant*.

*2. Conclusions and comment on the results*
This work has allowed us to characterize the levels of risk to health and safety from exposure to chemical agents of Company X workers. The analysis was developed for all substances with an estimated risk methodology, proposed by the Piedmont Region, i.e. without direct measurements of pollutant concentrations.
For the homogeneous groups investigated, for all the substances in use an IRRELEVANT level of risk was obtained for health and low for safety. In these cases it is not necessary to use devices other than those already in use (low quantities and frequency of use, closed-circuit systems, use of PPE).
The measures in place fully compensate for the risks. The planned measures include constant attention to the maintenance of low quantities and low frequencies of use, to the maintenance of PPE and equipment.
However, it is advisable to maintain the periodic monitoring plan of the extractor hoods to ensure that the capture speed is sufficient to prevent the dispersion of pollutants (about 0.5 m/s). The existence of this plan was in fact taken into account in the review of the Risk Indicators for the substances used.
The risk (irrelevant or irrelevant) of any entity is recommended to include, among the improvement measures, a training and information activity for the laboratory staff in a manner proportionate to the nature and danger of the substance or chemical used.
If the risk to workers' health proves to be "not irrelevant" there is an obligation on the part of the Employer to arrange for health surveillance, as well as other measures envisaged by articles 225, 226, 229 and 230 of Legislative Decree 81/08.
If there are no substantial changes over the years it can reasonably be assumed that it is not necessary to repeat the measures.
When there have been substantial changes it is necessary to make a new measurement.
In this case it is not necessary to use devices other than those already in use (low quantities and frequencies of use, closed-circuit systems, use of PPE). The measures in place fully compensate for the risks. The planned measures include constant attention to the maintenance of low quantities and low frequencies of use, to the maintenance of PPE and equipment.
However, it is advisable to maintain the periodic monitoring plan of the extractor hoods to ensure that the capture speed is sufficient to prevent the dispersion of pollutants (about 0.5 m/s).
Among the improvement measures adopted there is a training and information activity for laboratory workers in a manner proportionate to the nature and danger of the substance or chemical used.

## References

1. Legislative Decree 81/08
2. Legislative Decree 28 July 2008, n. 145
3. Legislative Decree 14 March 2003, n. 65
4. Regulation (EC) No. 1272/20083