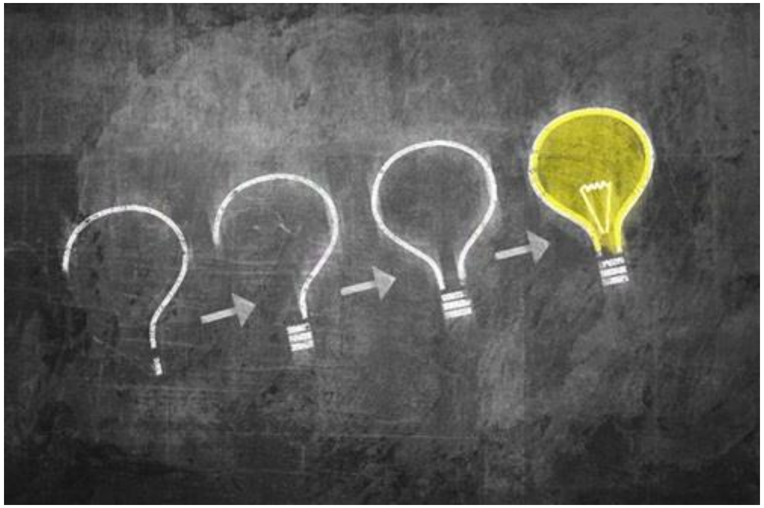
# 3. General Method of Risk Assessment

With this method you can recognize the risks and dangers in **any situation**. When you know the risks, you can search for the methods to minimize them.



# SUVA method for assessing and mitigating risks in work processes

- Excerpts from the training materials -

The Suva method is used for in-depth risk analysis of workplaces and work processes. The application of this method requires sound knowledge and is therefore reserved for specialists in occupational safety. If you need the support of a specialist, please refer to the guideline on the involvement of occupational physicians or other occupational safety specialists (ASA-Richtlinie). The following slides present a simplified form of risk assessment.

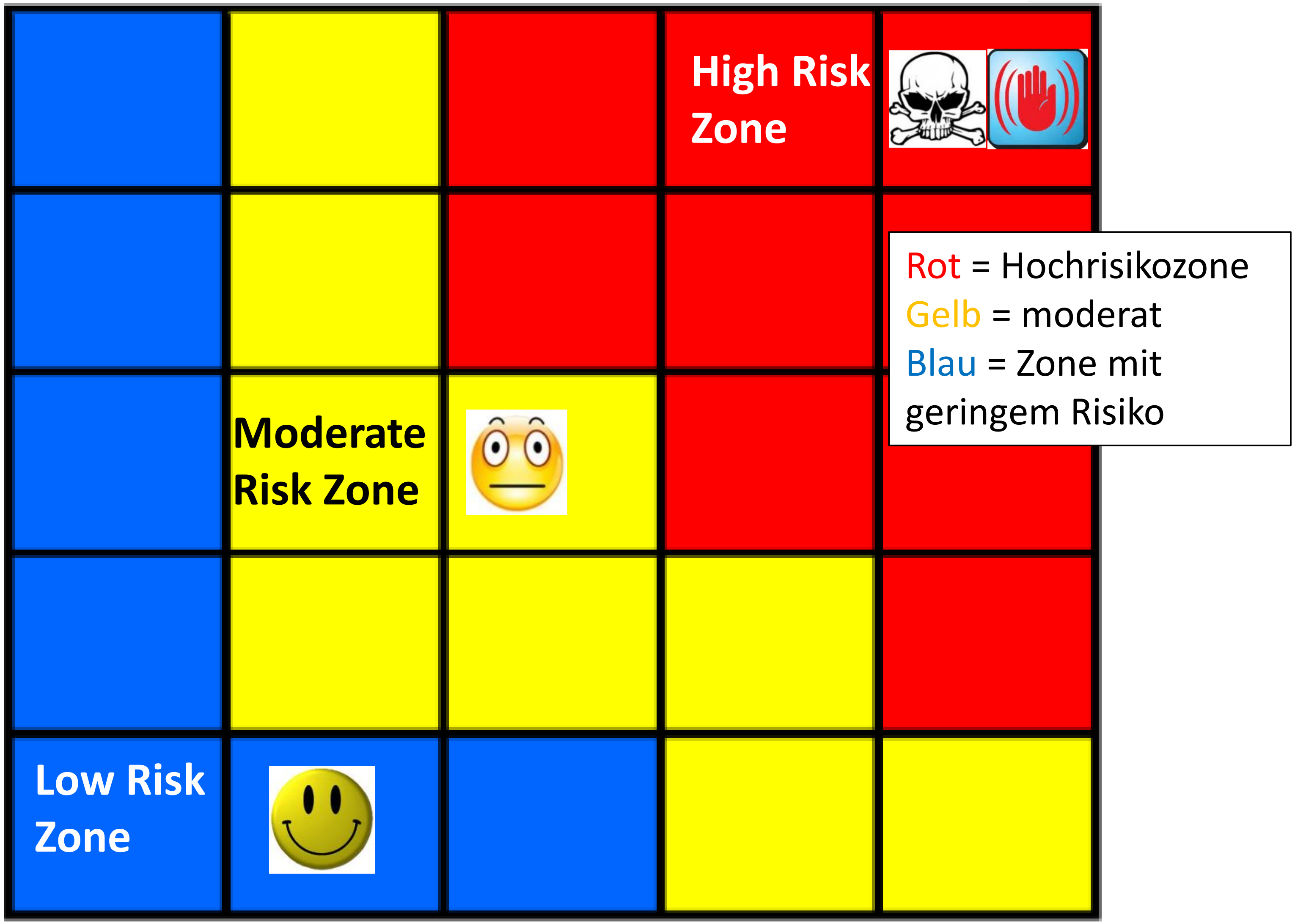
Risk assessment and mitigation consists of these steps:

1. Establish boundaries of the work system
2. Identify mitigate hazards
3. Assess risk
4. Evaluate risk
5. Mitigate risk, take risk measures
6. Check effect of measures
7. Describe residual risk

## The aim of the Risk Assessment:

– to promote risk and **safety awareness**, to prevent misjudgments.
– to find out what legal basis, what training, what **guidelines** exist for the handling of products/devices, of procedures, of a project.
– to find out what **specific risks and hazards** are caused by a product, a process, a project, a device and to determine which measures are suitable to exclude or minimize them.
– to find out whether the **appropriate** environment, method, equipment, materials and tools are **available** for a process or project.
– to find out which safety precautions, which safety infrastructures, which safety equipment are **required**.
– to find out which preventive measures must be in place in order to be able to react efficiently in the **event of an incident**.
– to find out whether **alternatives** with lower risks and hazards are available for hazardous projects.

## Assess the risks of the project, of the experiment with the help of the risk diagram



**High Risk:** The probability for an incident is high.


**Moderate Risk:** We have an acceptable risk. The safety measures are sufficient.

**Low Risk:** The probability for an incident is low.

Let's take an example from the sports world for the risk assessment.

**Base-Jumping vs. Tennis**

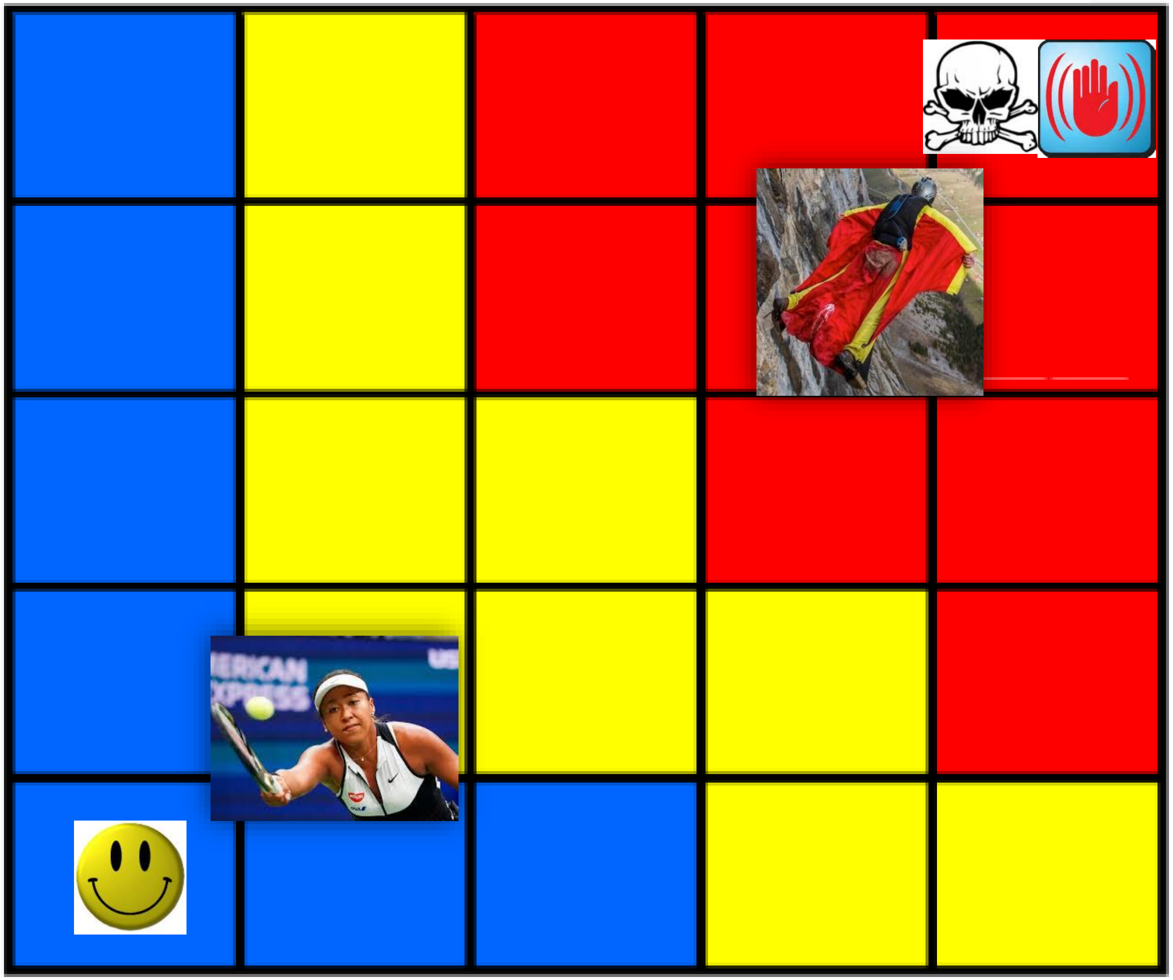
## Identify risks zones

Perhaps we realize we are moving in a higher risk area. The aim is to find methods to minimize the risks. So we want to get from the red zone down to the blue zone.

**Example:**

**Base-Jumping = High Risk**

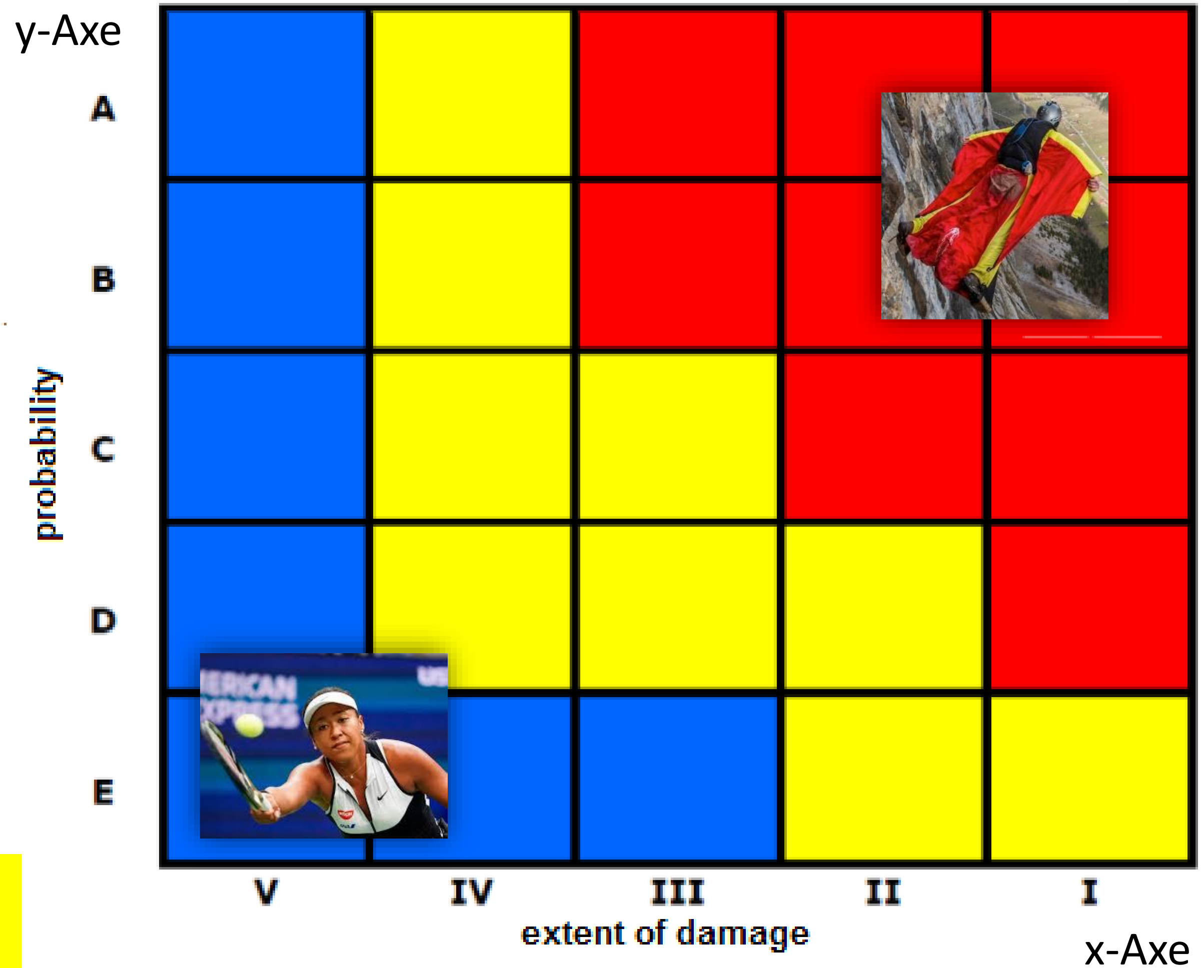
**Tennis = Low Risk**



# The axes of the diagram

probability

| | |
|---|---|
| A | often |
| B | sporadic |
| C | rare |
| D | unlikely |
| E | essentially impossible |




**Example Base-Jumping:**
**In Switzerland, around 71 people died in accidents between 2011 and 2020.**
**Risiko = A - I**

| | |
|---|---|
| I | Death |
| II | Severe permanent health damage |
| III | Light permanent health damage |
| IV | Curable medical damage losing work time |
| V | Curable medical damage without losing work time |

Uli Emanuele gained notoriety for a base jump flight through a 2-meter narrow hole in a rock in the Lauterbrunnen Valley near the Rottal Glacier, which he recorded with a helmet camera and posted online. The video received over seven million clicks on YouTube within a very short time.

This **high-risk** venture succeeded, but.....

The base jumper in the video was…

Artikel | Diskussion | Lesen | Bea

WIKIPEDIA
Die freie Enzyklopädie

Hauptseite
Themenportale
Zufälliger Artikel

Mitmachen

Artikel verbessern
Neuen Artikel anlegen
Autorenportal
Hilfe
Letzte Änderungen
Kontakt
Spenden

Werkzeuge

Links auf diese Seite
Änderungen an verlinkten Seiten
Spezialseiten
Permanenter Link
Seiteninformationen
Wikidata-Datenobjekt
Artikel zitieren

Drucken/exportieren

Buch erstellen
Als PDF herunterladen
Druckversion

In anderen Sprachen

Italiano
Links bearbeiten

# Uli Emanuele

**Uli Emanuele** (* 23. Oktober 1985 in Südtirol; † 17. August 2016 im Lauterbrunnental) war ein professioneller italienischer Basejumper.

## Leben [ Bearbeiten | Quelltext bearbeiten ]

Emanuele wurde in Italien geboren und lernte dort den Beruf des Druckers, zog aber später in die Schweiz und arbeitete auf einem Berggasthof als Tellerwäscher, da er Basejumpen, seit April 2015 betrieb er den Sport unter dem Sponsor GoPro hauptberuflich.[2]

Bekanntheit erlangte Emanuele durch einen Sprung durch eine 2 m schmale Felswand im Lauterbrunnental nahe dem Rottalgletscher, den er mit einer Helmkamera aufr YouTube und Emanuele hatte mehrere Auftritte, u. a. bei Markus Lanz.[1]

Emanuele starb am 17. August 2016 im Alter von 30 Jahren bei einem Basejump im Lauterbrunnental in den Schweizer Alpen, in dem vor ihm bereits mehr als 40 andere

## Einzelnachweise [ Bearbeiten | Quelltext bearbeiten ]


1. ↑ [a] [b] *GoPro-Star starb beim Wingsuit-Flug. Grosse Trauer um «Künstler der Lüfte» Uli Emanuele (†29).* Blick.ch. 25. August 2016, abgerufen am 28. August 20
2. ↑ *Basejumper Uli Emanuele (†30) stirbt in den Dolomiten. Diese waghalsigen Stunts machten ihn zur Legende.* Bild.de. 19. August 2016, abgerufen am 28. Aug
3. ↑ *Base-Jumper Uli Emanuele stürzt in den Tod.* Sueddeutsche.de. 19. August 2016, abgerufen am 29. August 2016.
4. ↑ *Uli Emanuele und mehr als 40 weitere Extremsportler starben hier. Das Tal der toten Basejumper.* Bild.de. 20. August 2016, abgerufen am 29. August 2016.
5. ↑ *Gegen Fels geprallt. Basejumper Uli Emanuele: Das Rätsel um den Todessprung.* Abendzeitung München. 19. August 2016, abgerufen am 29. August 2016.


Normdaten (Person): Wikipedia-Personensuche

Kategorien: Basejumper | Extremsportler (Schweiz) | Ext

Emanuele died on August 17, 2016, at the age of 30 during a base jump in the Lauterbrunnen Valley in the Swiss Alps, in which more than 40 other extreme athletes had died before him.


Diese Seite wurde zuletzt am 19. November 2016 um 17:15 Uhr bearbeitet

Abrufstatistik · Autoren

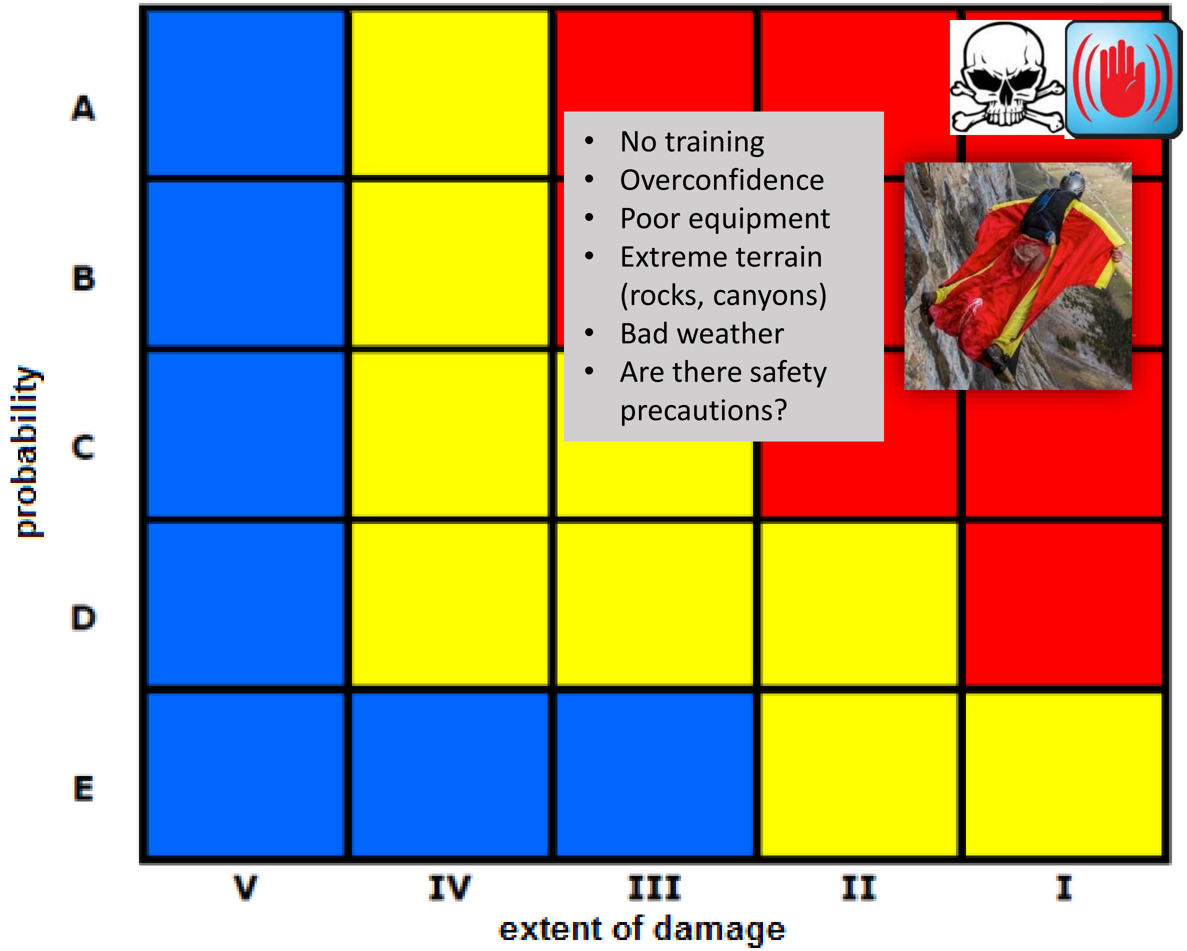
Der Text ist unter der Lizenz „Creative Commons Attribution/Share Alike“ verfügbar; Informationen zu den Urhebern und zum Lizenzstatus eingebundener Mediendateien (etwa Bilder oder Videos) können im Rege die Nutzung dieser Website erklären Sie sich mit den Nutzungsbedingungen und der Datenschutzrichtlinie einverstanden.
Wikipedia® ist eine eingetragene Marke der Wikimedia Foundation Inc.

Datenschutz Über Wikipedia Impressum Entwickler Statistiken Stellungnahme zu Cookies Mobile Ansicht

# Hazard risk (without risk assessment and without safety recommendations)

**Start your risk assessment this way (As-is status):**

Evaluate all hazards and risks (including all procedures). Judge all existing security structures (is sufficient protection in place?).



Which factors must be taken into account in a risk assessment?

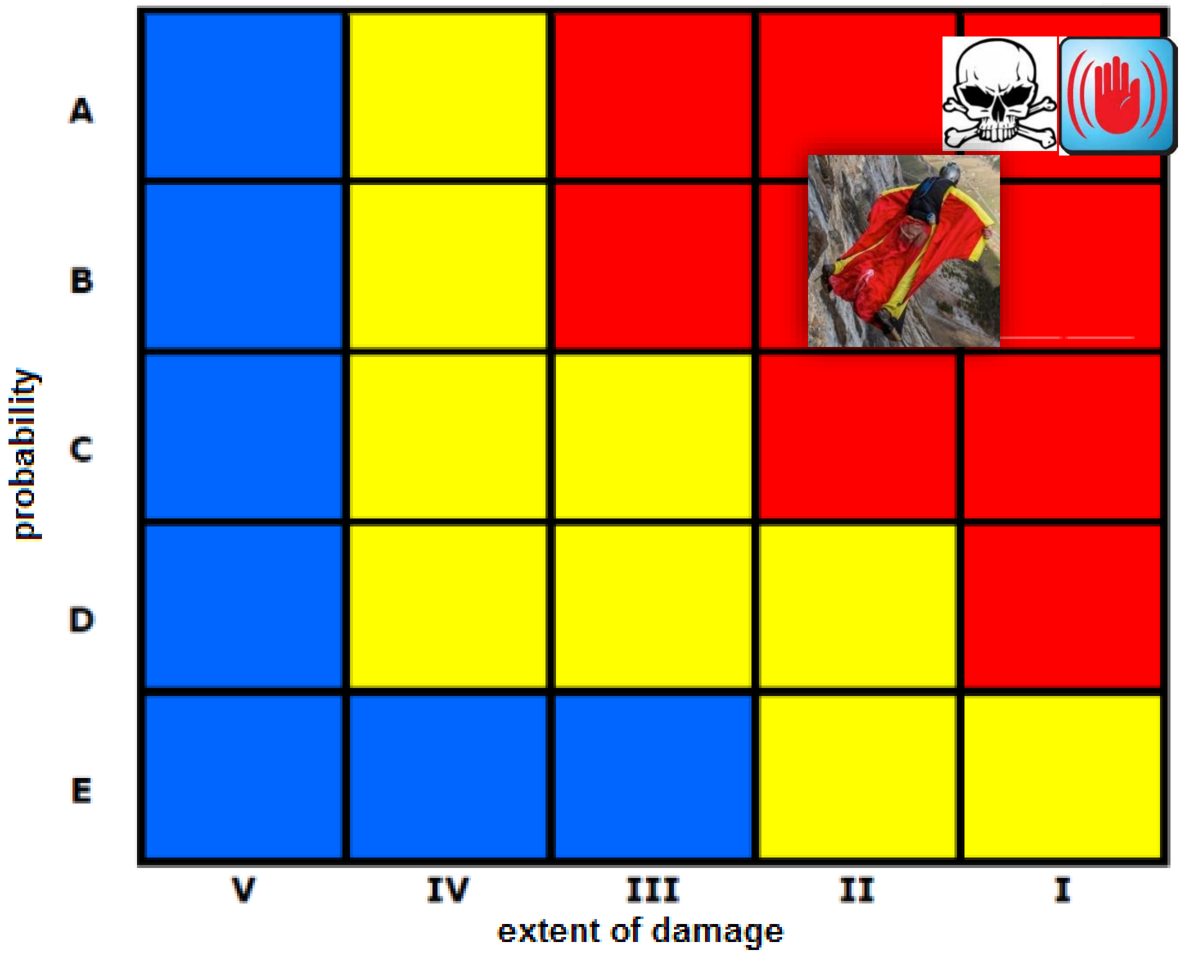
- The **description of the project** (what dimensions, what quantities, what environment)
- Clarification of **qualifications**, required training, responsibilities, necessary permits and so on
- Selection of the **best method**; if the best method is too risky: Are there **alternatives**?
- Are there **experience values**?
- Evaluation of the **Safety Data Sheets of all substances** to be processed
- Are **suitable technologies/equipment** available?
- Is one **prepared for a possible accident**? Is the fire fight and rescue material prepared?
- and so on

## Evaluate risks

Next, you need to estimate or calculate the risks. To do this, estimate or calculate the probability of occurrence (e.g. as a percentage) and the negative impact for each risk. Include stakeholders in the assessment. They know best what the probability of a particular risk is and what the consequences of its occurrence would be in their area. Work with a qualitative assessment if necessary (low, medium, high, etc.). If necessary, calculate the risk value from the product of probability of occurrence and impact. The higher the risk value, the greater the risk.

**If your final results have a high risk level (e.g. example A - I)**

- you should **not be allowed** to work in a laboratory!
- you should **refrain** from a certain procedure or project!



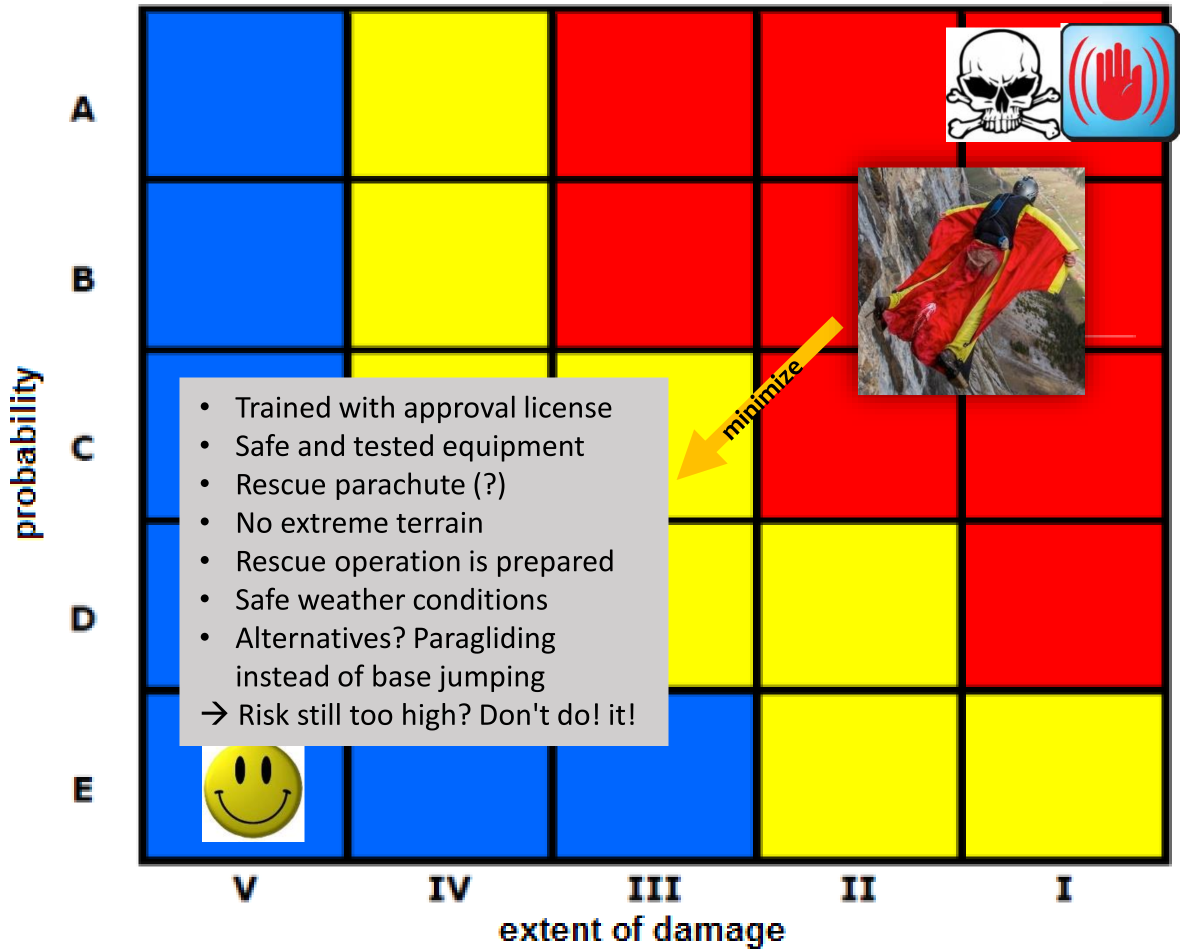

**Risk assessment of the Base-Jumping project:**

**Risk = A - I**

# Residual risk (with implementation of all safety recommendations)

**Next step:**

Evaluate all necessary safety infrastructure, operating rules, and preventive measures needed to minimize hazards and risks for this project.



## Evaluate and define measures for risk minimization

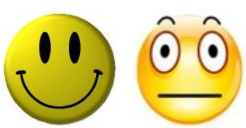
- In this step, you define possible actions to mitigate a risk and select the best one.
- Start with the top risks, i.e. incidents that can occur frequently and have a high negative impact.
- Make sure that risk management decisions are made at the right level.
- Be sure to weigh costs and benefits. Risks with low probability of occurrence and low harm do not require a comprehensive mitigation strategy.
- Distribute the implementation of measures. The rule is: My goal, my risk, my action(s). Individuals responsible for the goal are also responsible for risk mitigation.

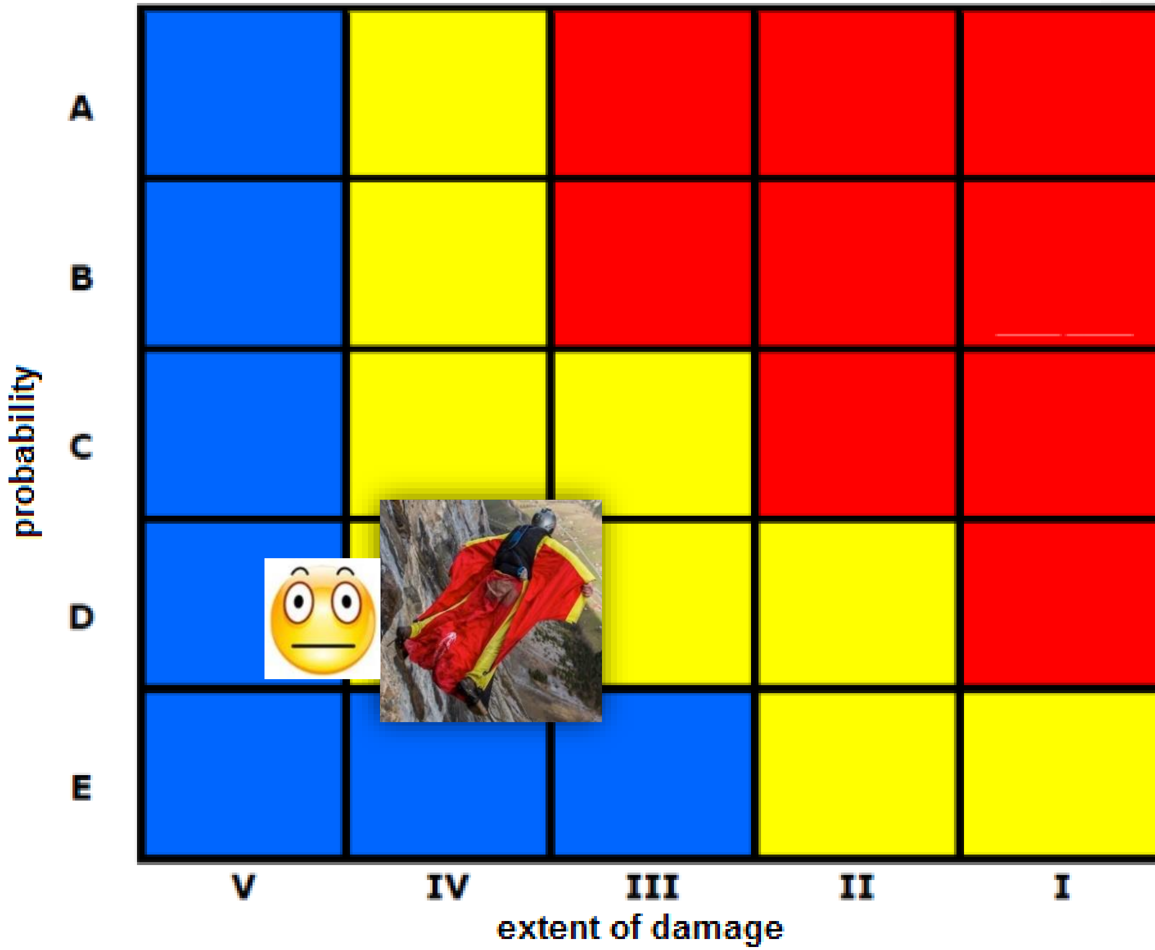
# Residual risk (with implementation of all safety recommendations)

**After the implementation of all measures:**

Perhaps then, the result of your risk assessment will go down to **III-D** (**III** = light permanent health damage / **D** = unlikely to happen).

**What may remain is an acceptable residual risk!**





# Template paper for the risk assessment (simplified version)

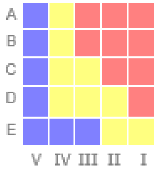
Link: www.su-management.ethz.ch → Safety → Safety Lecture

ETH Zürich, HCI Building

| | | | |
|---|---|---|---|
| **Work domain:** | | **Date:** | |
| **Department/Institute/Branch** | | **Author:** | |
| **Risk assessment (short procedure):** | | **Consultation:** | |

## Identification of hazards – Risk assessment

| No. | Target function / Task | No. | Hazard, Hazard situation, Hazard event | Health damage | Risk | | |
|---|---|---|---|---|---|---|---|
| | | | | | E | P | Zone |
| 1 | Process/Object | 1.1 | Description of hazard / Current state (without measures) | Assessment of potential extent of damage | I | A | 1 |
| | | 1.2 | | | | | |
| 2 | | 2.1 | | | | | |
| 3 | | 3.1 | | | | | |
| 4 | | 4.1 | | | | | |
| 5 | | 5.1 | | | | | |




| Extent of damage (E) | | Probability (P) | | Zone (Z) |
|---|---|---|---|---|
| I | Death | A | Often | Zone 1: High risk zone |
| II | Severe permanent health damage | B | Sporadic | Zone 2: Moderate risk zone |
| III | Light permanent health damage | C | Rare | Zone 3: Low risk zone |
| IV | Curable medical damage losing worktime | D | Unlikely | |
| V | Curable medical damage without losing worktime | E | Essentially impossible | |

ETH Zürich, HCI Building

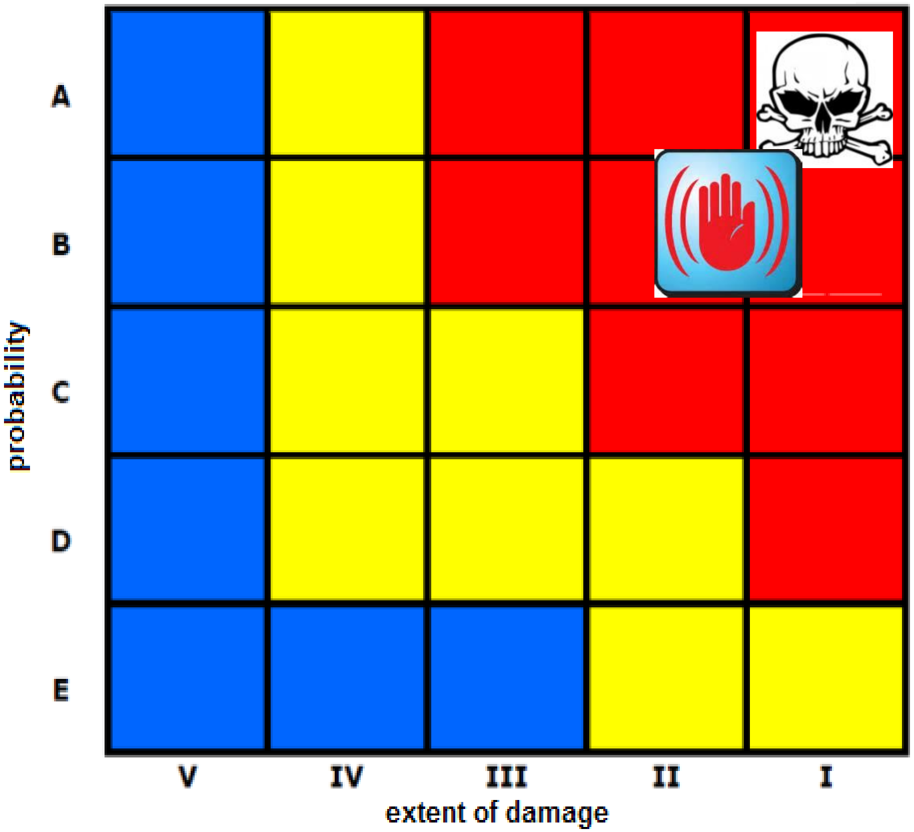
| | | | |
|---|---|---|---|
| **Work domain:** | | **Date:** | |
| **Department/Institute/Branch** | | **Author:** | |
| **Risk assessment (short procedure):** | | **Consultation:** | |

**Plan of measures and actions**

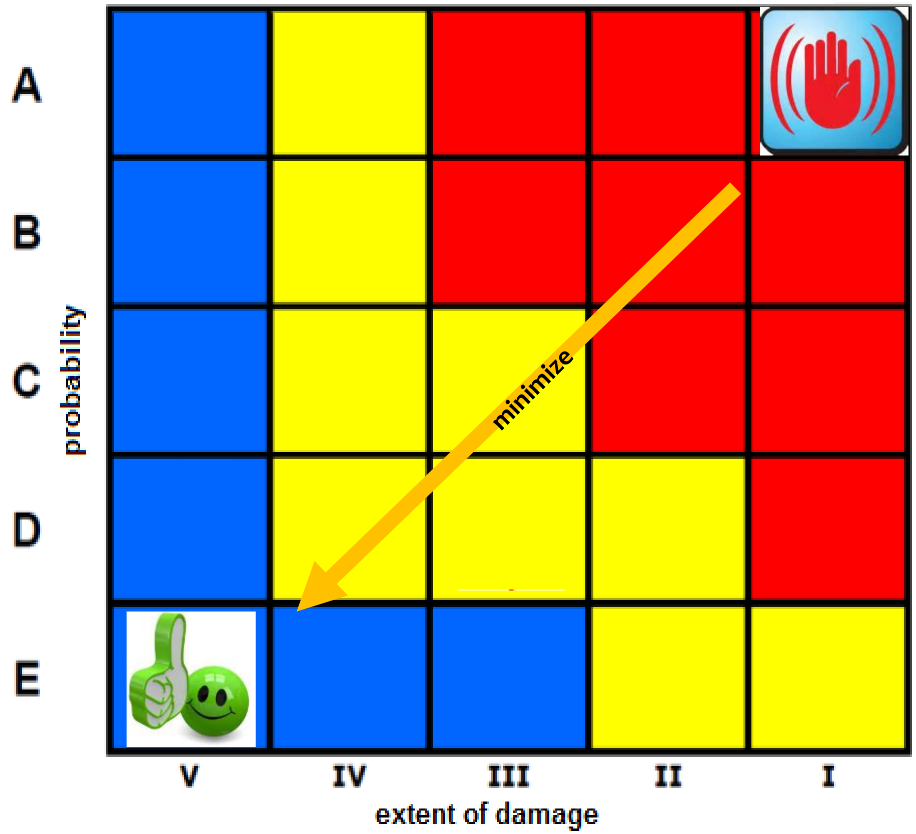
| No. | Measures<br>- Immediate measures<br>- Definite measures<br>- Measures in the safety concept | Risk zones | | Date | Responsible person / instance | Control by responsi-ble person / instance | Completed (Date/Sig nature) |
|---|---|---|---|---|---|---|---|
| | | Before | After | | | | |
| 1. | Description of measures for risk minimization | 1 | 3 | | | | |
| 2. | | | | | | | |
| 3. | | | | | | | |
| 4. | | | | | | | |
| 5. | | | | | | | |

Risk assessments are the best justification for investing in safety equipment. No employer will deny that.

**Hazard risk** (**without** risk assessment and without safety recommendations)




**Residual risk** (**with** implementation of all safety recommendations)



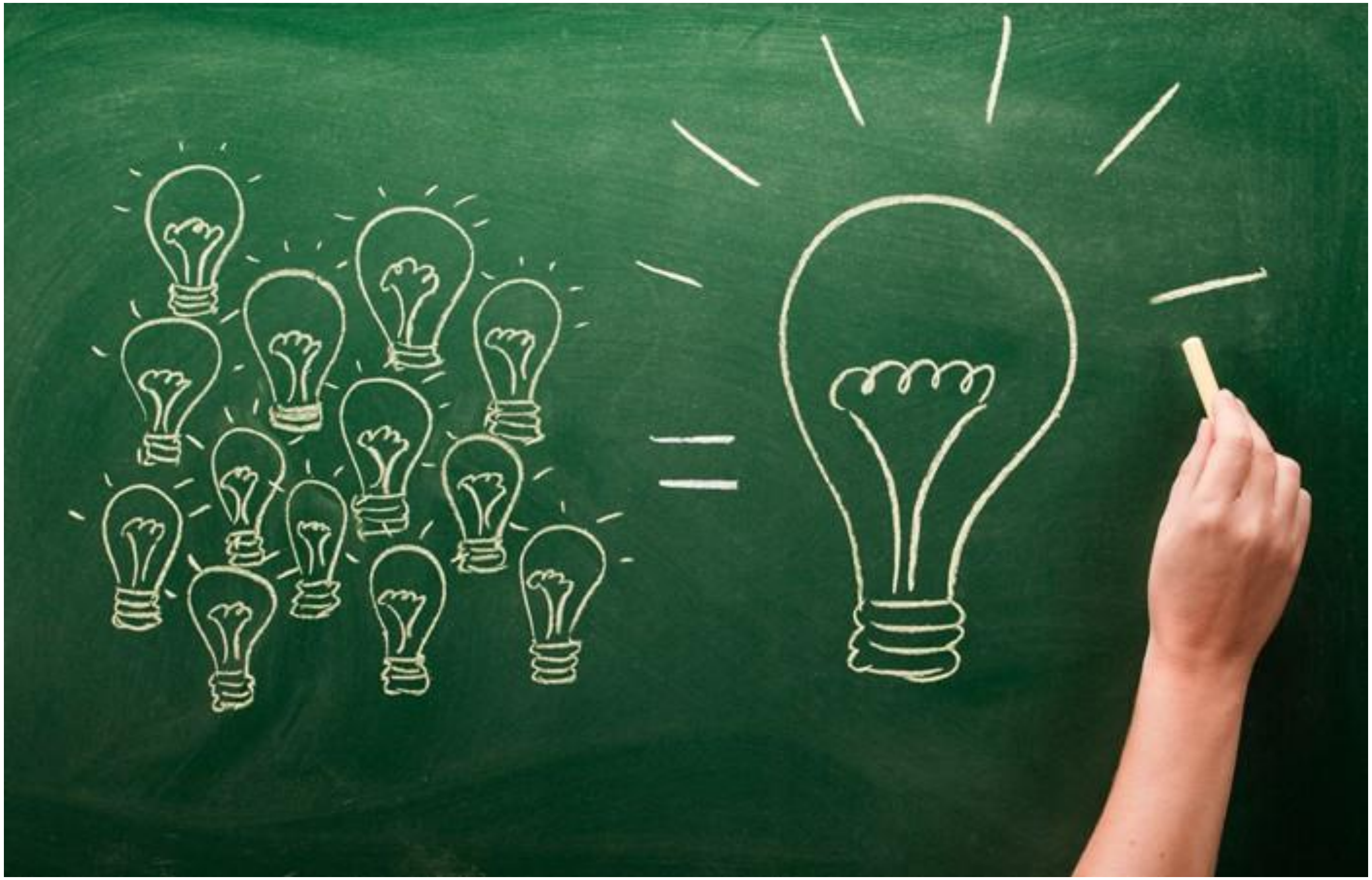
## After implementing the recommendations: Monitor risks!

The final step is to constantly monitor risks.

- How often does a negative incident actually occur?
- How effectively do countermeasures reduce the extent of damage?
- What alternative techniques now exist to reduce a risk?
- What additional risks have arisen as a result of new developments?

The management of risks is not a flash in the pan. Conduct analysis on a regular basis.

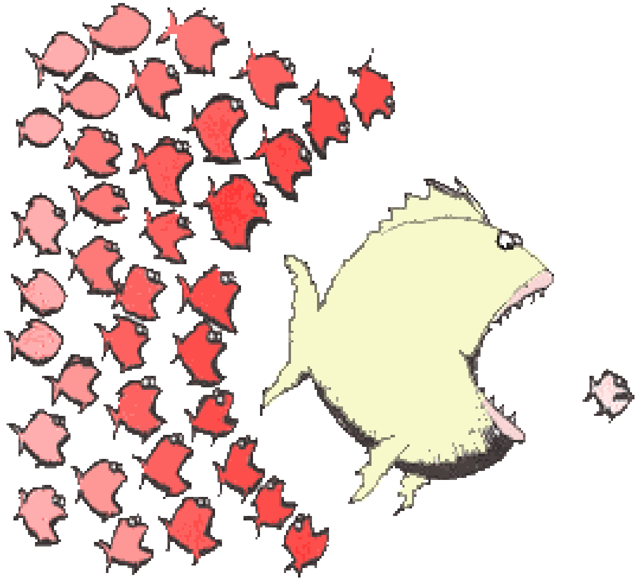
Note: In high-risk cases, carry out the risk assessment in a team rather than alone. Ensure every relevant detail is recognized.



# Golden rules:

The smaller the amount, the lower the risk!

Never work alone!



Know What to Do With Lab Accidents!

and so on!

**Note:**

It is **your responsibility** to carry out a risk analysis **before working** in a laboratory.
Teaching assistant always know what their students are doing.

The responsibility of the safety management CHAB is to provide the necessary infrastructure. Tell us what you need for the best possible safety.

We can advise you on all safety issues; contact us at: chab-safety@chem.ethz.ch

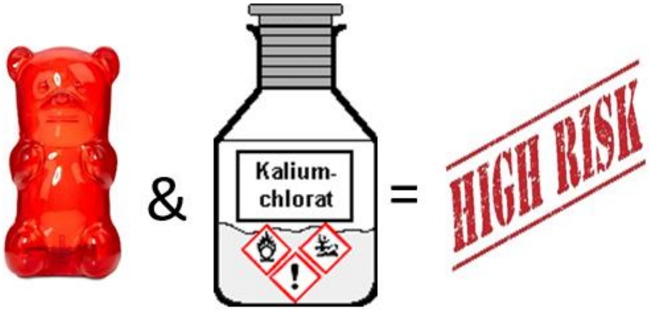

GET INSPIRED BY THIS EXAMPLE

ETH Zürich, HCI Building

# The description of the project

simplified version

| | | | |
|---|---|---|---|
| Work domain: | SU Management | Date: | today |
| Department/Institute/Branch | D-CHAB | Author: | |
| Risk assessment (short procedure): | Experiment in the lecture hall | Consultation: | |

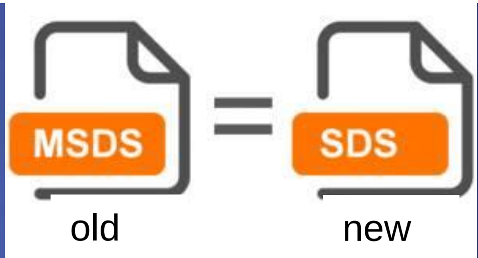
| **Title** | **Photo** |
|---|---|
| Description of the starting position, of the process, of the object<br><br>**A risk assessment for a gummy bear burning experiment in the Lecture Hall (Live).**<br><br>For this experiment we need potassium chlorate, a burner and gummy bears.<br>What are the risks and dangers?<br><br> |  |

**Demonstrating dangerous experiments** without safety awareness and safety measures often leads to accidents with fatal consequences.


…..for the preparation of the risk assessment:

Evaluation of the **Safety Data Sheets** of all substances to be processed!

# Each chemical has a safety data sheet (SDS)




## Safety Data Sheets

Information should be presented as follows

1. Identification
2. Hazard(s) identification
3. Composition/information on ingredients
4. First-aid measures
5. Fire-fighting measures
6. Accidental release measures
7. Handling and storage
8. Exposure controls/personal protection
9. Physical and chemical properties
10. Stability and reactivity
11. Toxicological information
12. Ecological information
13. Disposal considerations
14. Transport information
15. Regulatory information
16. Other information.

**There are total 16 sections!**

Important for our experiment: The data sheet of potassium chlorate!

# The data sheet of potassium chlorate

**SIGMA-ALDRICH**

sigma-aldrich.com

Identification

## SAFETY DATA SHEET

according to Regulation (EC) No. 1907/2006
Version 5.2 Revision Date 09.05.2014
Print Date 26.08.2015

**SECTION 1: Identification of the substance/mixture and of the company/undertaking**

**1.1 Product identifiers**

| | | |
|---|---|---|
| Product name | : | Potassium chlorate |
| Product Number | : | 255572 |
| Brand | : | Sigma-Aldrich |
| Index-No. | : | 017-004-00-3 |
| REACH No. | : | A registration number is not available for this substance as the substance or its uses are exempted from registration, the annual tonnage does not require a registration or the registration is envisaged for a later registration deadline. |
| CAS-No. | : | 3811-04-9 |

**1.2 Relevant identified uses of the substance or mixture and uses advised against**

| | | |
|---|---|---|
| Identified uses | : | Laboratory chemicals, Manufacture of substances |

**1.3 Details of the supplier of the safety data sheet**

| | | |
|---|---|---|
| Company | : | Sigma-Aldrich Company Ltd. |

## SECTION 2: Hazards identification


### 2.1 Classification of the substance or mixture

**Classification according to Regulation (EC) No 1272/2008**

Oxidizing solids (Category 1), H271
Acute toxicity, Oral (Category 4), H302
Acute toxicity, Inhalation (Category 4), H332
Chronic aquatic toxicity (Category 2), H411

For the full text of the H-Statements mentioned in this Section, see Section 16.

**Classification according to EU Directives 67/548/EEC or 1999/45/EC**

| | | |
|---|---|---|
| N | Dangerous for the environment | R51/53 |
| O | Oxidising | R 9 |
| Xn | Harmful | R20/22 |

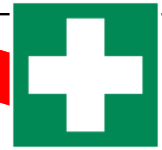
For the full text of the R-phrases mentioned in this Section, see Section 16.

### 2.2 Label elements

**Labelling according Regulation (EC) No 1272/2008**

| | |
|---|---|
| Pictogram |  |
| Signal word | Danger |
| Hazard statement(s) | |
| H271 | May cause fire or explosion; strong oxidiser. |
| H302 + H332 | Harmful if swallowed or if inhaled |
| H411 | Toxic to aquatic life with long lasting effects. |
| Precautionary statement(s) | |
| P220 | Keep/Store away from clothing/ combustible materials. |
| P273 | Avoid release to the environment. |

## SECTION 4: First aid measures



### 4.1 Description of first aid measures

**General advice**
Consult a physician. Show this safety data sheet to the doctor in attendance.

**If inhaled**
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

**In case of skin contact**
Wash off with soap and plenty of water. Consult a physician.

**In case of eye contact**
Flush eyes with water as a precaution.

**If swallowed**

### 4.2 Most important symptoms and effects, both acute and delayed
The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

### 4.3 Indication of any immediate medical attention and special treatment needed
no data available

## SECTION 5: Firefighting measures

### 5.1 Extinguishing media

**Suitable extinguishing media**
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

### 5.2 Special hazards arising from the substance or mixture
Hydrogen chloride gas, Potassium oxides

### 5.3 Advice for firefighters
Wear self contained breathing apparatus for fire fighting if necessary.

### 5.4 Further information
Use water spray to cool unopened containers.

## SECTION 6: Accidental release measures

**6.1 Personal precautions, protective equipment and emergency procedures**

Use personal protective equipment. Avoid dust formation. Avoid breathing vapours, mist or gas. Ensure adequate ventilation. Evacuate personnel to safe areas. Avoid breathing dust.
For personal protection see section 8.

**6.2 Environmental precautions**

Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.

**6.3 Methods and materials for containment and cleaning up**

Sweep up and shovel. Contain spillage, and then collect with an electrically protected vacuum cleaner or by wet-brushing and place in container for disposal according to local regulations (see section 13). Keep in suitable, closed containers for disposal.

**6.4 Reference to other sections**

For disposal see section 13.


## SECTION 7: Handling and storage

**7.1 Precautions for safe handling**

Avoid contact with skin and eyes. Avoid formation of dust and aerosols.
Provide appropriate exhaust ventilation at places where dust is formed.Keep away from sources of ignition - No smoking.
For precautions see section 2.2.

**7.2 Conditions for safe storage, including any incompatibilities**

Store in cool place. Keep container tightly closed in a dry and well-ventilated place.

**7.3 Specific end use(s)**

Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

## SECTION 8: Exposure controls/personal protection

### 8.1 Control parameters

**Components with workplace control parameters**
Contains no substances with occupational exposure limit values.

### 8.2 Exposure controls

**Appropriate engineering controls**
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

**Personal protective equipment**

**Eye/face protection**
Safety glasses with side-shields conforming to EN166 Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

**Skin protection**
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

The selected protective gloves have to satisfy the specifications of EU Directive 89/686/EEC and the standard EN 374 derived from it.

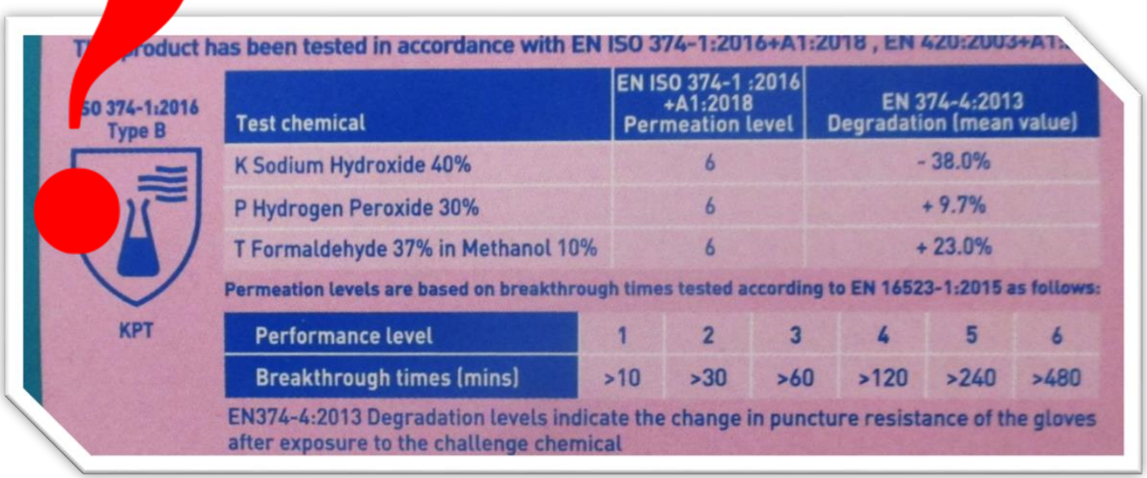
Full contact
Material: Nitrile rubber
Minimum layer thickness: 0.11 mm
Break through time: 480 min
Material tested:Dermatril® (KCL 740 / Aldrich Z677272, Size M)

Splash contact
Material: Nitrile rubber
Minimum layer thickness: 0.11 mm
Break through time: 480 min
Material tested:Dermatril® (KCL 740 / Aldrich Z677272, Size M)

and so on!

**By the way: What types of gloves are there?** How do you choose these? How do you interpret the packaging informations?



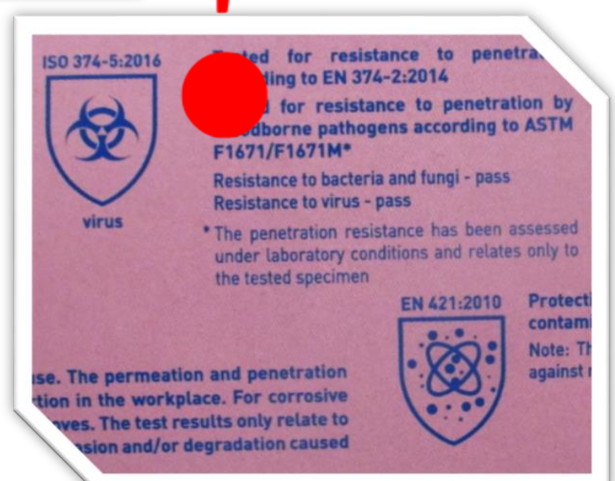



| Test chemical | EN ISO 374-1 :2016 +A1:2018 Permeation level | EN 374-4:2013 Degradation (mean value) |
|---|---|---|
| K Sodium Hydroxide 40% | 6 | - 38.0% |
| P Hydrogen Peroxide 30% | 6 | + 9.7% |
| T Formaldehyde 37% in Methanol 10% | 6 | + 23.0% |

Permeation levels are based on breakthrough times tested according to EN 16523-1:2015 as follows:

| Performance level | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Breakthrough times (mins) | >10 | >30 | >60 | >120 | >240 | >480 |

EN374-4:2013 Degradation levels indicate the change in puncture resistance of the gloves after exposure to the challenge chemical



# Safety Lecture Practice Module

## Subject 1: Gloves in the lab

⤓ Correct selection and handling of gloves (PDF, 4.4 MB)

## Subject 2: Dosage and Transfer of Liquids

⤓ Dosage and Transfer of Liquids (PDF, 1.3 MB)

## Subject 3: Overpressure Situations - How To Avoid Them

⤓ Overpressure Situations (PDF, 2 MB)

# SAFETY IN THE LABORATORY
# FIND THE RIGHT GLOVE!


Open the QR code and find all the necessary information there

SU Management

www.su-management.ethz.ch
27.6.22 / TM

For the risk assessment always study the hazard symbols and safety data (SDS) **<u>in detail</u>** before working with chemicals, whether harmless or dangerous.

**This is mandatory!**

Follow the recommendations on the SDS. If you can`t follow these basic rules, don’t work in a laboratory!

If no SDS data are available, it must be ensured that all possible risk factors have been considered.

Recommended websites:

www.reaxys.com

or researching via the platform

www.infozentrum.ethz.ch

# Is there a Safety Data Sheet of Gummi Bears?

Natural and Artificial Gummy Bear Flavor
5/6/2014
Page 1 of 3

Flavor West Manufacturing LLC.
598 Crane St.
Lake Elsinore, Ca. 92530

**Material Safety Data Sheet**

Emergency Phone Number: 951-893-5120

| | |
|---|---|
| **Section 1.** | **Chemical Identification** |
| Product Name: | Natural and Artificial Gummy Bear Flavor |
| **Section 2.** | **Composition/Information of Ingredients** |
| CAS No.: | N/A |
| FEMA No.: | N/A |
| Molecular Formula: | N/A |
| Ingredients: | Gummy Bear Water Soluble Flavoring. Ingredients: Natural and Artificial Flavoring, Propylene Glycol. |
| **Section 3.** | **Hazards Identification** |
| Inhalation: | Repeated overexposure may be harmful. |
| Skin Contact: | No skin irritation is expected with normal use. However, skin irritation may occur with prolonged or excessive contact. |
| Eye Contact: | Direct exposure to large amounts may cause eye irritation, but no permanent eye injury is expected. |
| Ingestion: | No adverse effects expected with normal use. |
| **Section 4.** | **First-Aid Measures** |
| Inhalation: | Provide with fresh air |
| Skin Contact: | Remove all contaminated clothing and wash skin with plenty of water |
| Eye Contact: | Rinse thoroughly with plenty of water and seek medical advice |
| Ingestion: | Immediately drink plenty of water and seek medical advice |
| **Section 5.** | **Fire Fighting Measures** |
| Extinguishing Media: | $CO_2$; Foam; Dry Chemical |
| Special Procedures: | Wear protective clothing to prevent contact with skin and eyes |
| **Section 6.** | **Accidental Release Measures** |
| Person Related: | Ensure supply of fresh air in enclosed rooms |
| Spills: | Absorb spills with vermiculite or other suitable material and remove to an approved disposal container. Dispose in accordance with current laws and regulations. |
| **Section 7.** | **Handling and Storage** |
| Handling: | No special handling required |
| Storage: | Tightly closed in a well ventilated area |


Page 2 of 3

**Exposure Controls/Personal Protection**
Avoid contact with eyes, skin, clothing
No special requirements
Wear protective goggles
Wear suitable gloves
Change contaminated clothing; wash hands after working with substance

**Physical and Chemical Properties**
Liquid
Level: Clear Golden Liquid.
Gummy Bear
Not available
N/A
Not available
Not available
Not available
Not available
20$^0$C: 1.04

Soluble
Soluble

**Stability and Reactivity**
l:
ization:
sition products:
: No information available

**Toxicological Information**
No information available
No information available
No information available
: May be harmful if inhaled, swallowed or absorbed through the skin

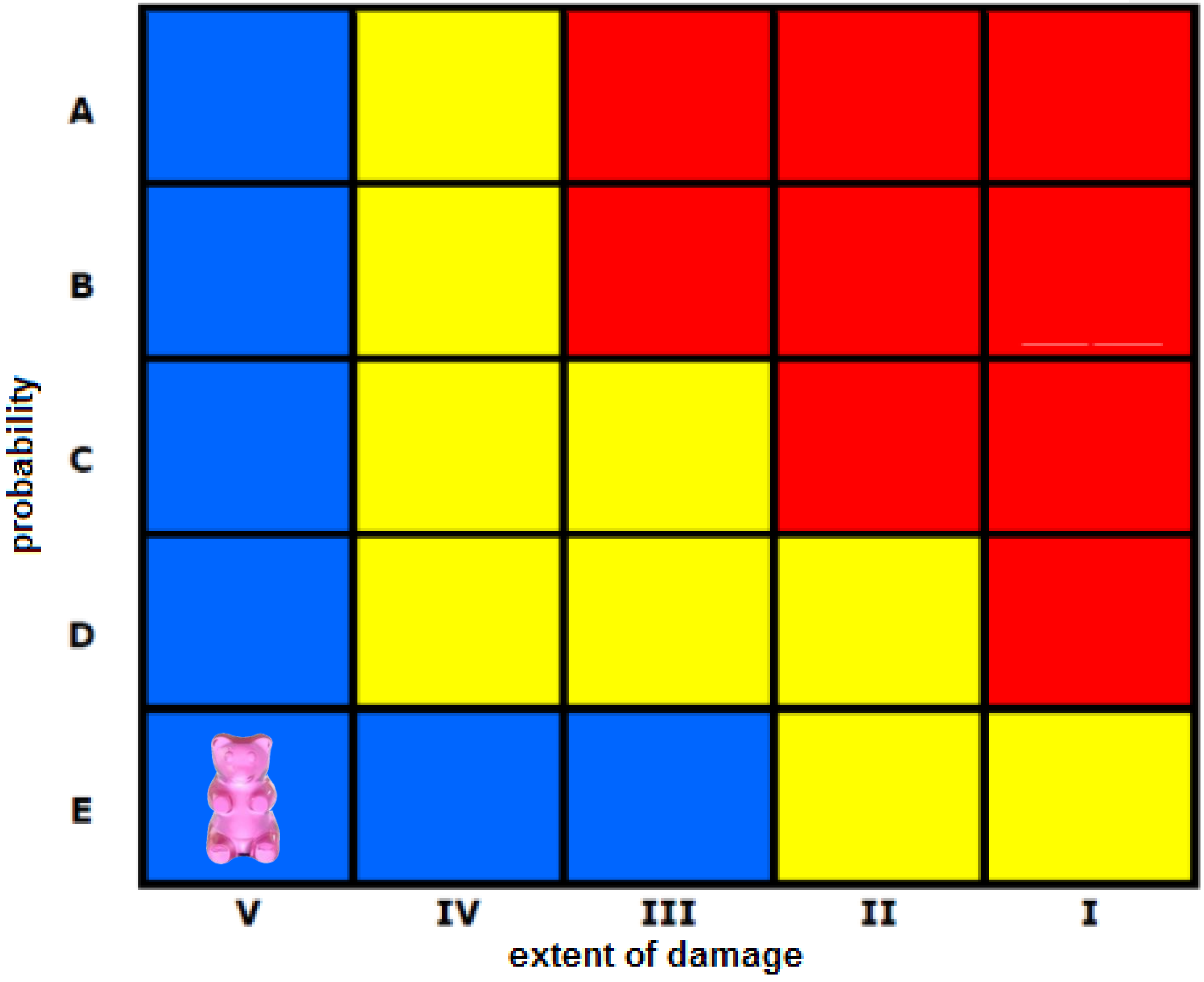
**Ecological Information**
No information available
No information available

**Disposal Considerations**
s generated by consumer use may be disposed of in a sanitary sewer
of water. Empty containers generated by consumer use may be

What are the risks of gummy bears?

or under what risks do gummy bears suffer?

Despite of all attempts to find risks in handling gummy bears: there are none



# What are the risks of potassium chlorate?

Potassium chlorate is a white stable salt. The compound is highly oxidizing.

Formula: $KClO_3$
Molecular wight: 122.55 g/mol
Melting Point: 356°C

It decomposes above 400°C:

$4\ KClO_3 \rightleftharpoons 3\ KClO_4 + KCl$ (400°C)
$3\ KClO_4 \rightleftharpoons 3\ KCl + 6\ O_2$ (500°C)

e.g. $C_6H_{12}O_6 + 6\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O$ ($\Delta H = -\ 2800$ kJ/mol)

**Chlorates form explosive mixtures with many oxidizable substances!**

**Calorimetry**

In the case of hazardous reactions, the results of a calorimeter are also relevant for the risk assessment. Calorimetry is a method for determining heat quantities and energy conversion. It can be used, for example, to measure the joule content of the **enthalpy** released by chemical reactions or the energy released during metabolic processes in organisms.

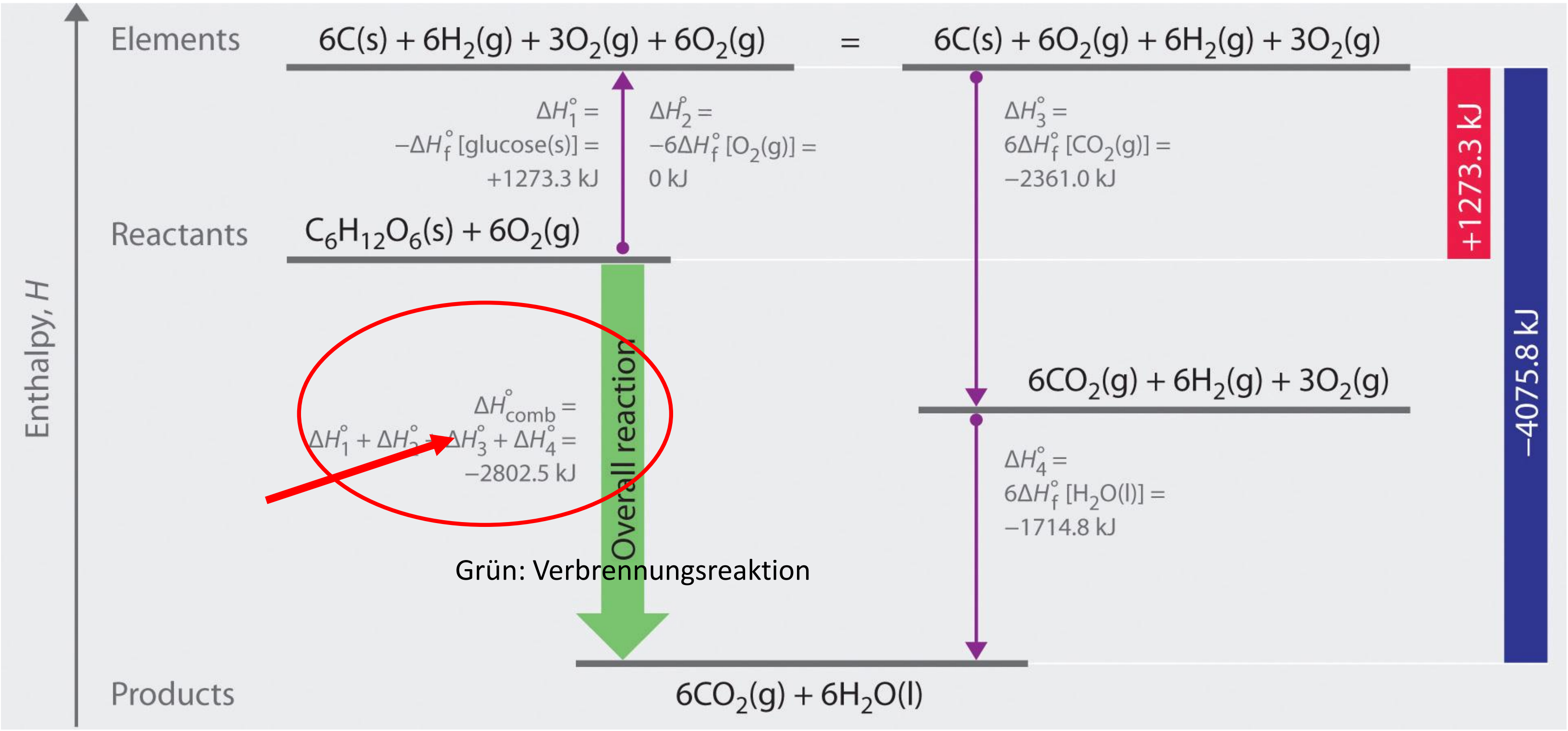
**Reaction calorimeters** are calorimeters optimized for chemical applications. They are used in chemical process development to measure the heat generated during a reaction and the time course of the output. The thermal data obtained are needed for the safety assessment of the process and the design of reactor cooling systems.

The **heat of reaction** is referred to as enthalpy of reaction and abbreviated as ΔHR. It is the energy that a system releases to or extracts from the environment as heat at constant pressure. The total energy of a reaction is called reaction energy.

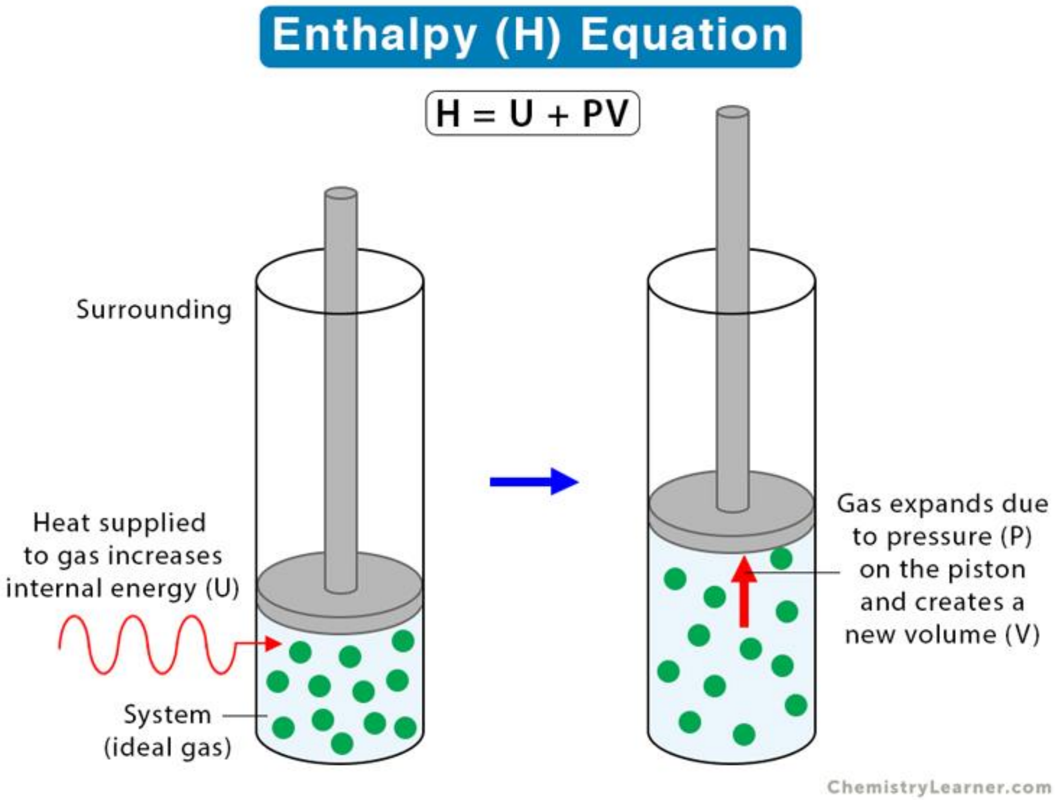
**Enthalpy** is a measure of the energy of a thermodynamic system. It is usually symbolized by the letter H (unit: joule, J).

A thermochemical cycle for the combustion of glucose

**A Thermochemical Cycle for the Combustion of Glucose.** Two hypothetical pathways are shown from the reactants to the products. The green arrow labeled $\Delta H^o_{comb}$ indicates the combustion reaction. Alternatively, we could first convert the reactants to the elements via the reverse of the equations that define their standard enthalpies of formation (the upward arrow, labeled $\Delta H^o_1$ and $\Delta H^o_2$ ). Then we could convert the elements to the products via the equations used to define their standard enthalpies of formation (the downward arrows, labeled $\Delta H^o_3$ and $\Delta H^o_4$ ). Because enthalpy is a state function, $\Delta H^o_{comb}$ is equal to the sum of the enthalpy changes $\Delta H^o_1 + \Delta H^o_2 + \Delta H^o_3 + \Delta H^o_4$.



Any physical or chemical process involves a change in enthalpy, which can be measured experimentally. When a process begins at constant pressure, the evolved heat (either absorbed or released) equals the change in enthalpy. Enthalpy change is the sum of internal energy denoted by U and product of volume and Pressure (PV), expressed in the following manner



## **«Death of a Gummy Bear»** in the lecture hall - What are the dangers and risks?

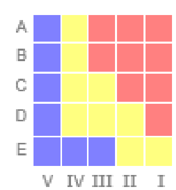
- The test tube may explode and spray the contents into the environment of the lecture hall.
- The sprayed potassium perchlorate would then react violently with organic matter and cause fire and injury, requiring evacuation.
- The hot contents of the test tube could be ejected in a similar manner, causing damage and burns as described above.
- The experiment would produce a lot of smoke, which would then spread through the lecture theatre and could possibly be toxic.
- There are no suitable intervention equipment that can be used in an emergency.

ETH Zürich, HCI Building

| | | | |
|---|---|---|---|
| **Work domain:** | **SU Management** | **Date:** | today |
| **Department/Institute/Branch** | **D-CHAB** | **Author:** | |
| **Risk assessment (short procedure):** | Experiment in the lecture hall | **Consultation:** | |

## Identification of hazards – Risk assessment

| No. | Target function / Task | No. | Hazard, Hazard situation, Hazard event | Health damage | Risk | | |
|---|---|---|---|---|---|---|---|
| | | | | | E | P | Zone |
| 1 | Object: Gummy bear | 1.1 | No risks identified | | V | E | 3 |
| 2 | Object: potassium chlorate | 2.1 | Description of hazard / Current state (without measures) | Assessment of potential extent of damage<br>In case of an accident: probable excessive damage (irreversible health damage, possibly fatal, significant loss of material) | I | A | 1 |
| | material compatibility | 2.2 | Possible violent reaction, even explosion, in contact with combustible/organic material (gloves, hoses, plastic utensils, skin, eyes) | | | | |
| | melt with an gas burner | 2.3 | Decomposes when heated above 400° C (closed Vessels may explode) | | | | |
| 3 | Reaction: potassium chlorate will be melted in a test tube and gum-my bears will be burned in the resulting liquid. | 3.1 | $C_6H_{12}O_6 + 6\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O$<br>$\Delta H = -2800$ kJ mol-1 | The larger the quantity, the great-er the extent of the risks and the extent of the damage. Particularly dangerous are reactions in closed vessels. | II | A | 1 |

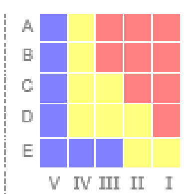



| Extent of damage (E) | | Probability (P) | | Zone (Z) |
|---|---|---|---|---|
| I | Death | A | Often | Zone 1: High risk zone |
| II | Severe permanent health damage | B | Sporadic | Zone 2: Moderate risk zone |
| III | Light permanent health damage | C | Rare | Zone 3: Low risk zone |
| IV | Curable medical damage losing worktime | D | Unlikely | |
| V | Curable medical damage without losing worktime | E | Essentially impossible | |

ETH Zürich, HCI Building

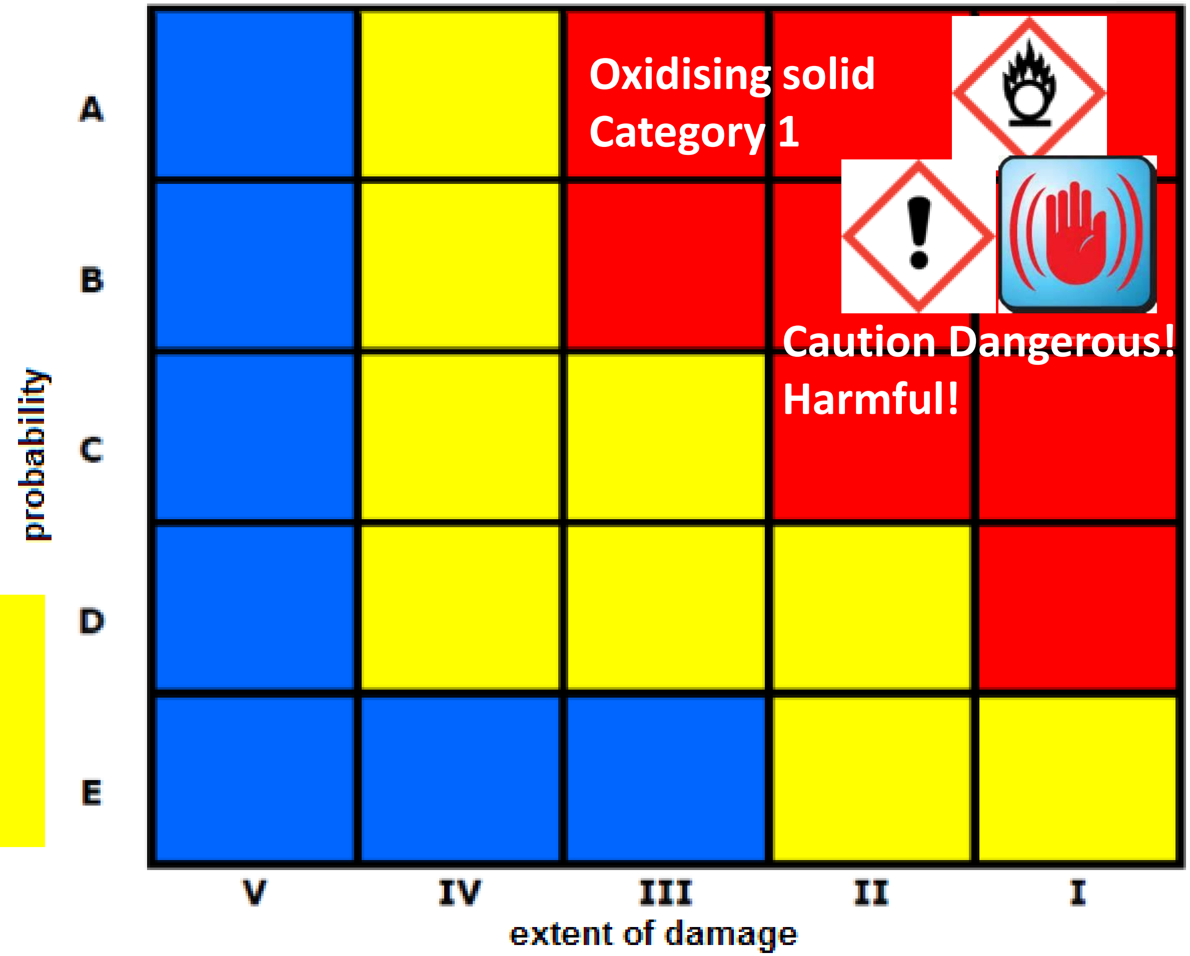
| | | | |
|---|---|---|---|
| **Work domain:** | **SU Management** | **Date:** | today |
| **Department/Institute/Branch** | **D-CHAB** | **Author:** | |
| **Risk assessment (short procedure):** | Experiment in the lecture hall | **Consultation:** | |

| No. | Target function / Task | No. | Hazard, Hazard situation, Hazard event | Health damage | Risk | | |
|---|---|---|---|---|---|---|---|
| | | | | | E | P | Zone |
| **4** | Process: Performing the Experiment in the lecture hall | 4.1<br>4.2<br>4.3 | **The test tube can explode,** spraying the contents into the surrounding area in the auditorium. The sprayed potassium perchlorate would then react violently with organic substances and cause fire and injuries, thus requiring evacuation.<br>**The hot contents of the test tube could be similarly splashed out,** causing damage and burns as described above.<br>**The experiment would produce a lot of smoke,** which would then spread through the auditorium and could be toxic under certain circumstances. | The test tube is open, not closed. The probability of an explosion is low, but the risks of deflagration, fire and smoke outbreak are given.<br>The danger of fire injury and smoke poisoning exists. | II | B | 1 |
| **5** | Preparedness in case of an incident | 5.1 | **Especially for this experiment there are no appropriate resources** that can be used in the event of an emergency. | An incident due to the experiment can spread uncontrollably | II | C | 1 |
| **6** | Disposal of the residues | 6.1 | No special risks identified | | V | E | 3 |




| Extent of damage (E) | | Probability (P) | | Zone (Z) |
|---|---|---|---|---|
| I | Death | A | Often | Zone 1: High risk zone |
| II | Severe permanent health damage | B | Sporadic | Zone 2: Moderate risk zone |
| III | Light permanent health damage | C | Rare | Zone 3: Low risk zone |
| IV | Curable medical damage losing worktime | D | Unlikely | |
| V | Curable medical damage without losing worktime | E | Essentially impossible | |

Conclusion: Working or experimenting with potassium chlorate involves **high risks**!

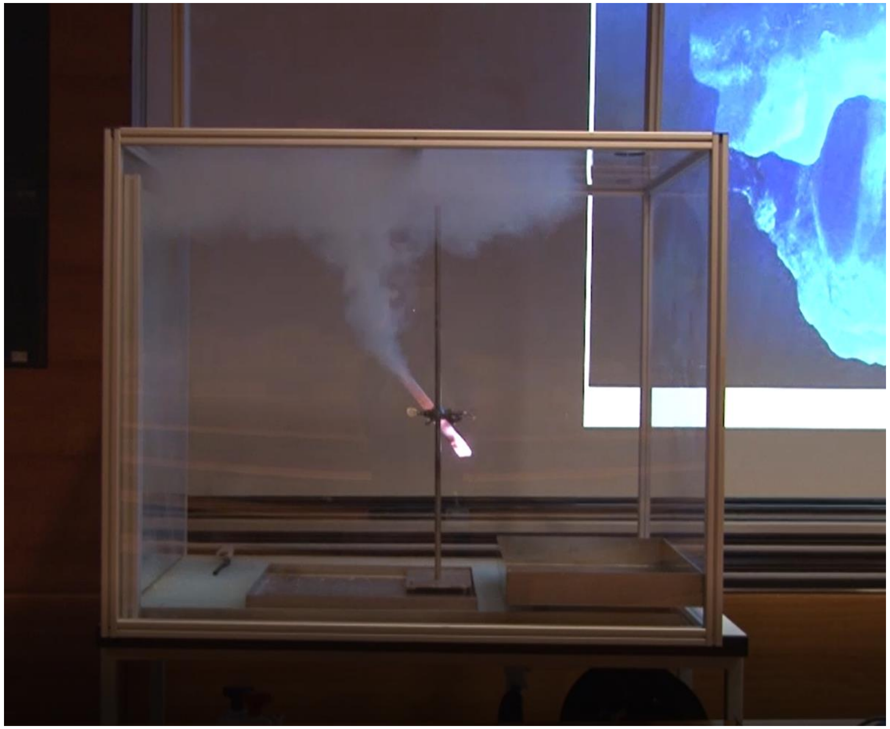



**Risk assessment of this project:**

**Risk = A - I**

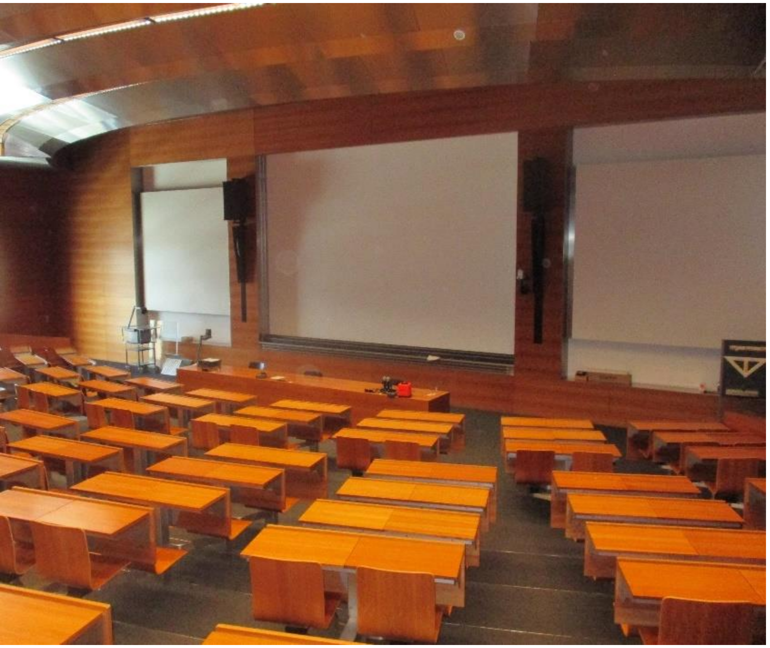
# Measures to minimise risks

- Instead of showing the experiment live in front of people, they show it as a video.
  → Reasonable alternative, but we preference of live experiment
- The smaller the quantity, the smaller the risk - that is, only small quantities of chemicals are used for the experiment.
- The experiment is carried out in a **fire-resistant safety cabin**.
- In the safety cabin, all organic and flammable materials that are not needed are removed before the experiment.



- However, **the safety cabin does not have an exhaust ventilation system**.
- The experiment will generate a lot of smoke, which will first collect in the safety cabin and then spread further into the auditorium. A preliminary test without spectators has shown that this is indeed the case.
- The smoke could set off fire alarms, possibly a sprinkler extinguishing system.
- Smoke is harmful to health because of its toxic components.

  → Consequence: Installation of gas filter at exhaust of safety cabin (but this is still not 100% guarantee that no smoke will be emitted)



ETH Zürich, HCI Building

| | | | |
|---|---|---|---|
| **Work domain:** | **SU Management** | **Date:** | today |
| **Department/Institute/Branch** | **D-CHAB** | **Author:** | |
| **Risk assessment (short procedure):** | Experiment in the lecture hall | **Consultation:** | |

## Plan of measures and actions

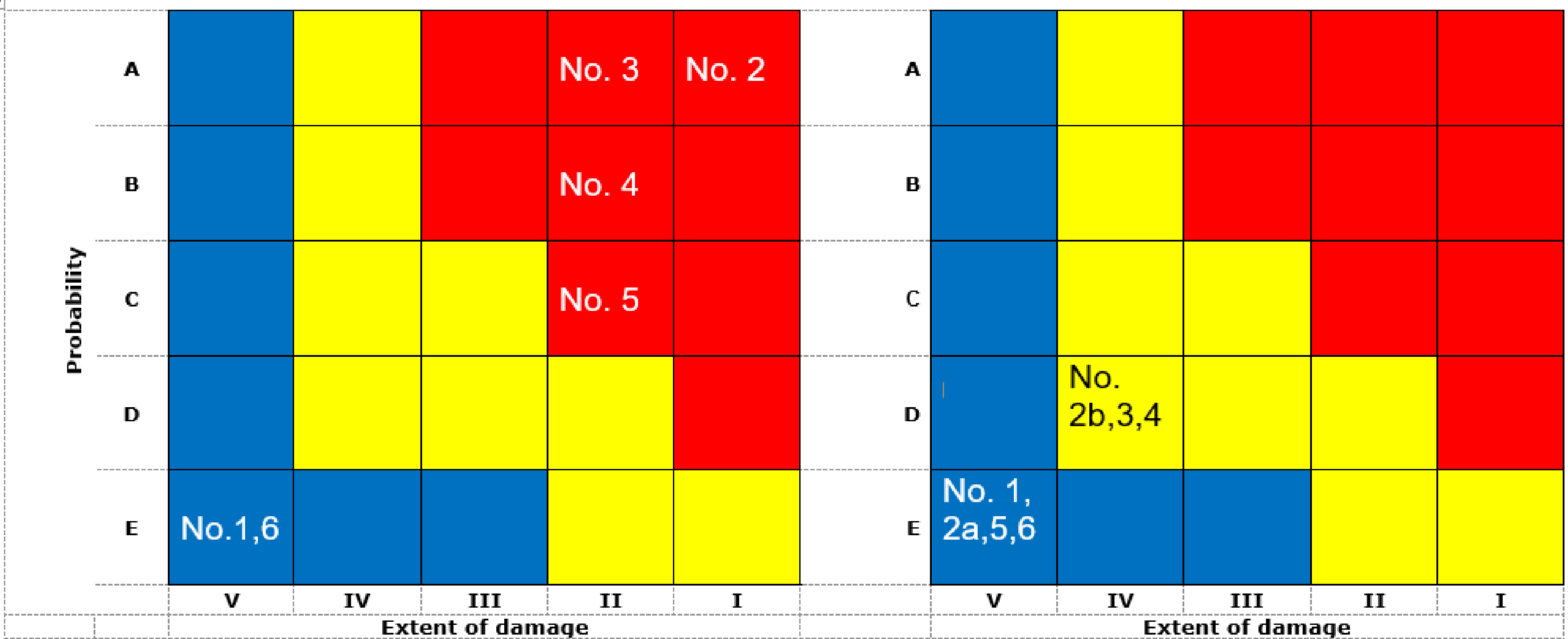
| **No.** | **Measures**<br>- Immediate measures<br>- Definite measures<br>- Measures in the safety concept | **Risk zones** | |
|---|---|---|---|
| | | **Before** | **After** |
| **1.** | Gummy bear | 3 | 3 |
| **2.** Proposed solution a | Object: potassium chlorate<br>Teachers and students in Germany may not work with potassium chlorate according to the German DGUV list 2017. **The use of films is recommended.** If the storage bottle is contaminated, an explosive mixture may be produced. For example, potassium chlorate forms friction-sensitive, explosive mixtures with sulfur, phosphorus, or carbon-containing compounds. **This will not be accepted as a solution.** | 1 | 3 |
| **2.** Proposed solution b | Object: potassium chlorate<br>**The reaction must be done behind a protective shield in a fume hood!**<br>There must be no combustible material near the test and the substrate must be fire-proof. Potassium chlorate is a very strong oxidizing agent, most organic substances are decomposed under fire or explosive phenomena. | 1 | 2 |
| **3.** | Reaction quantity<br>For the experiment we **use max. 15 g** of potassium chlorate | 1 | 2 |
| **4.** | Process: Performing the Experiment in the lecture hall<br>**The reaction will be carried out in the lecture hall in a safety cabin.** The safety cabin is not completely risk-free. To catch the smoke, an air filter device is used. | 1 | 2 |
| **5.** | Preparedness<br>In case of an accident we are well prepared | 1 | 3 |
| **6.** | Disposal of the residues | 3 | 3 |

| | | | |
|---|---|---|---|
| **Work domain:** | **SU Management** | **Date:** | today |
| **Department/Institute/Branch** | **D-CHAB** | **Author:** | |
| **Risk assessment (short procedure):** | Experiment in the lecture hall | **Consultation:** | |

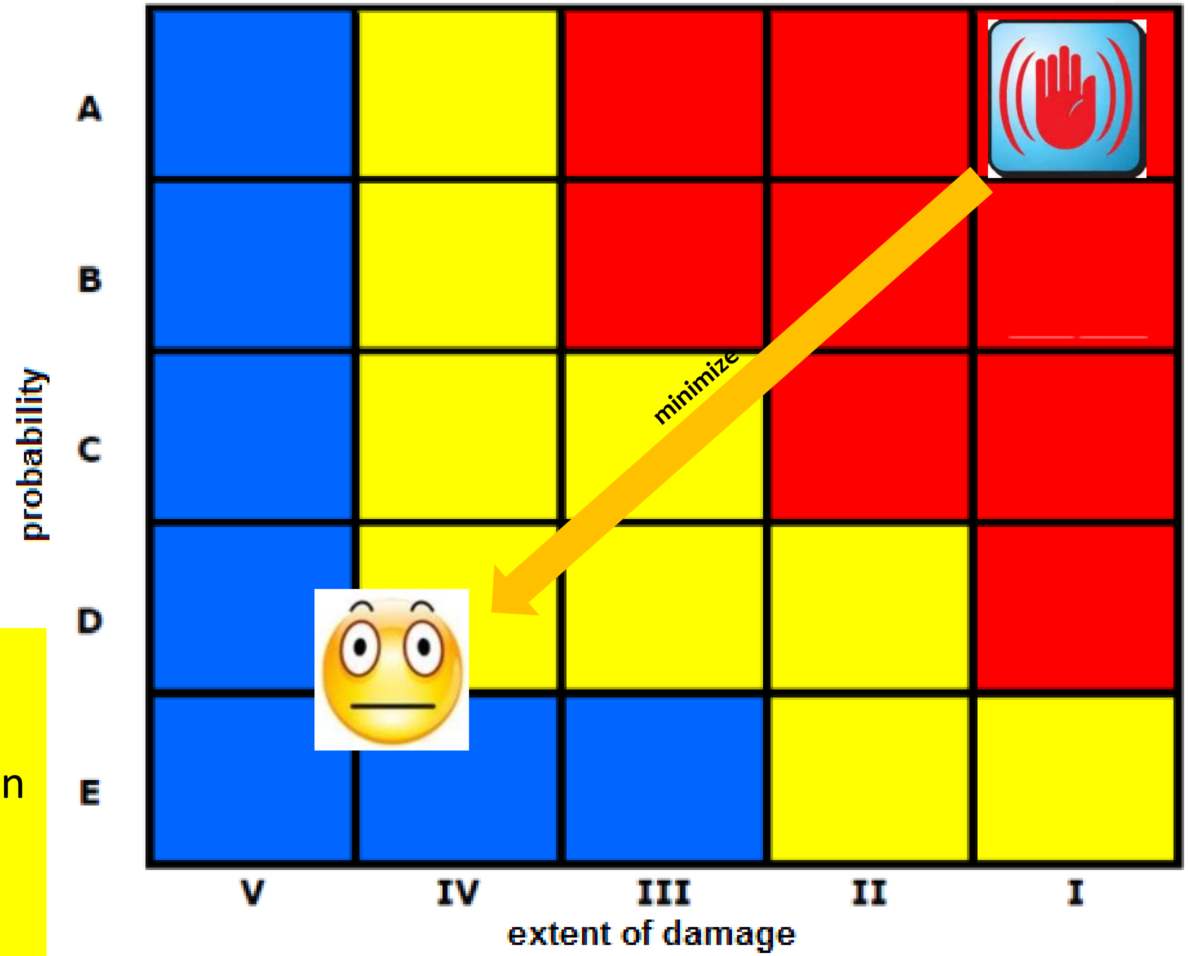
## Effectiveness of the measures

**Hazard risks (without safety recommendations)**

**Residual risks (after implementation of all listed safety recommendations)**



As you can see in this diagram, we have minimized the risks and we have sufficient protective measures. But we have a serious residual risk: Smoke!
**The question now is whether we accept this risk!**

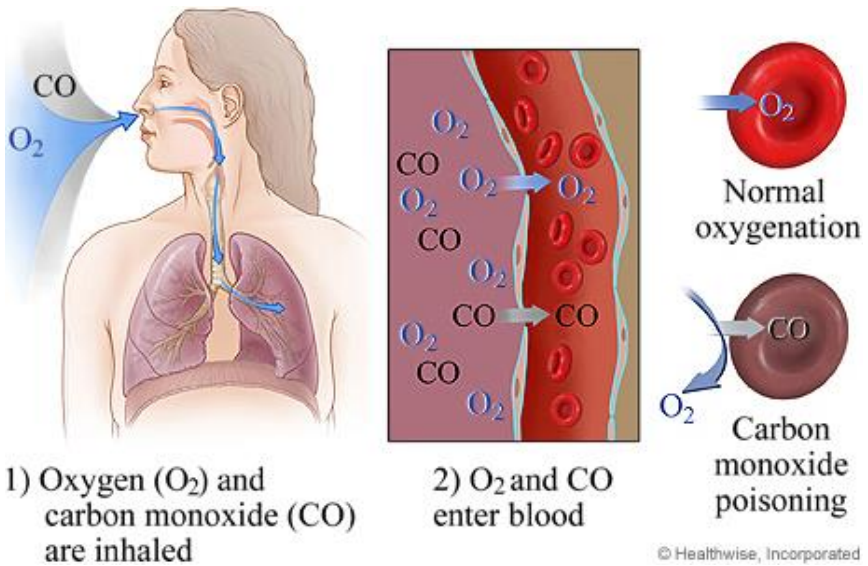



**Risk assessment of the project** after all recommendations have been implemented:

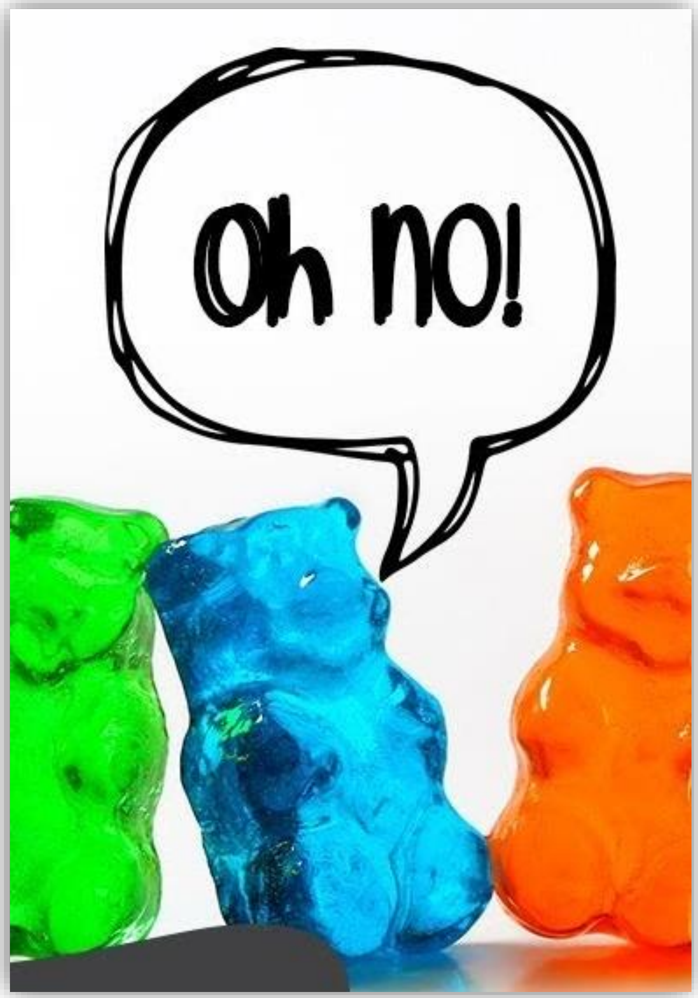
**Risiko = D - IV**

**Remaining residual risks must also be assessed.** During the experiment, a significant amount of smoke is produced, which potentially can set off smoke alarms; as well, the smoke, containing toxic gases, should not be inhaled.


| Concentration | Symptoms |
|---|---|
| 35 ppm (0.0035%) | Headache and dizziness within six to eight hours of constant exposure |
| 100 ppm (0.01%) | Slight headache in two to three hours |
| 200 ppm (0.02%) | Slight headache within two to three hours; loss of judgment |
| 400 ppm (0.04%) | Frontal headache within one to two hours |
| 800 ppm (0.08%) | Dizziness, nausea, and convulsions within 45 min; insensible within 2 hours |
| 1,600 ppm (0.16%) | Headache, increased heart rate, dizziness, and nausea within 20 min; death in less than 2 hours |
| 3,200 ppm (0.32%) | Headache, dizziness and nausea in five to ten minutes. Death within 30 minutes. |
| 6,400 ppm (0.64%) | Headache and dizziness in one to two minutes. Convulsions, respiratory arrest, and death in less than 20 minutes. |
| 12,800 ppm (1.28%) | Unconsciousness after 2–3 breaths. Death in less than three minutes. |

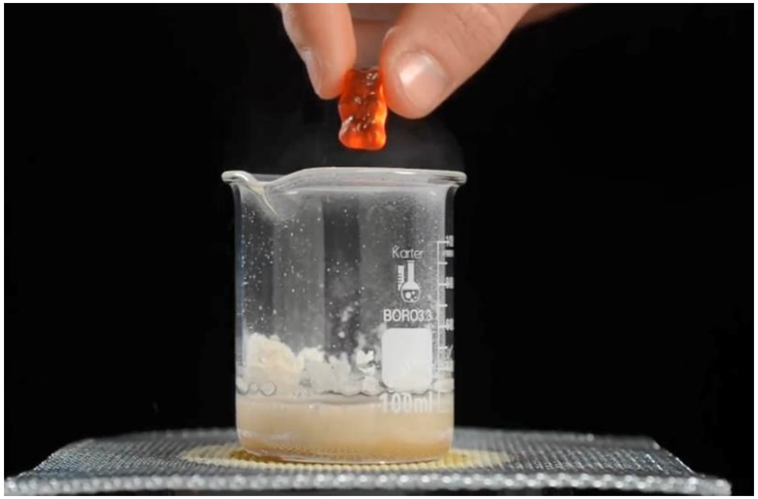


**Attention:** We start the experiment now....




....but online we cannot show the experiment, therefore now nevertheless the risk-free video.

# **Golden rule:** The smaller the amount, the lower the risk!




Link to the video: https://youtu.be/xYqTVZUHd08

This experiment has been presented to the public for 10 years now. Thanks to compliance with safety rules and the application of safety measures, an incident with this experiment is almost unlikely.

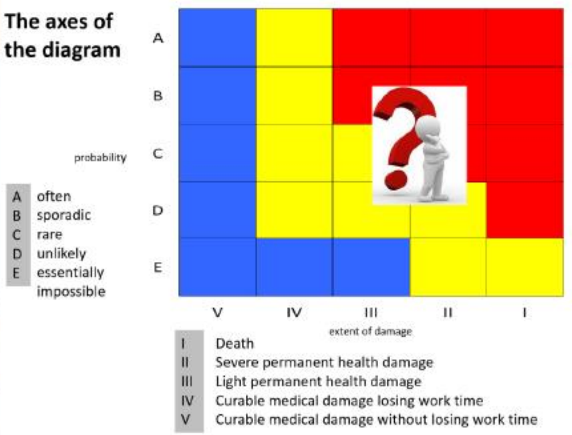
# Safety begins with you!

# The SLAM-Risk Assessment = Stop – Look – Analyze – Measures

## Stop

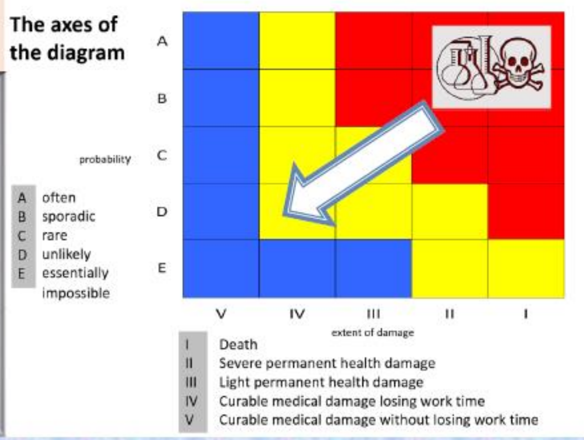
## Look

The axes of the diagram




## Analyze

The axes of the diagram




## Measures