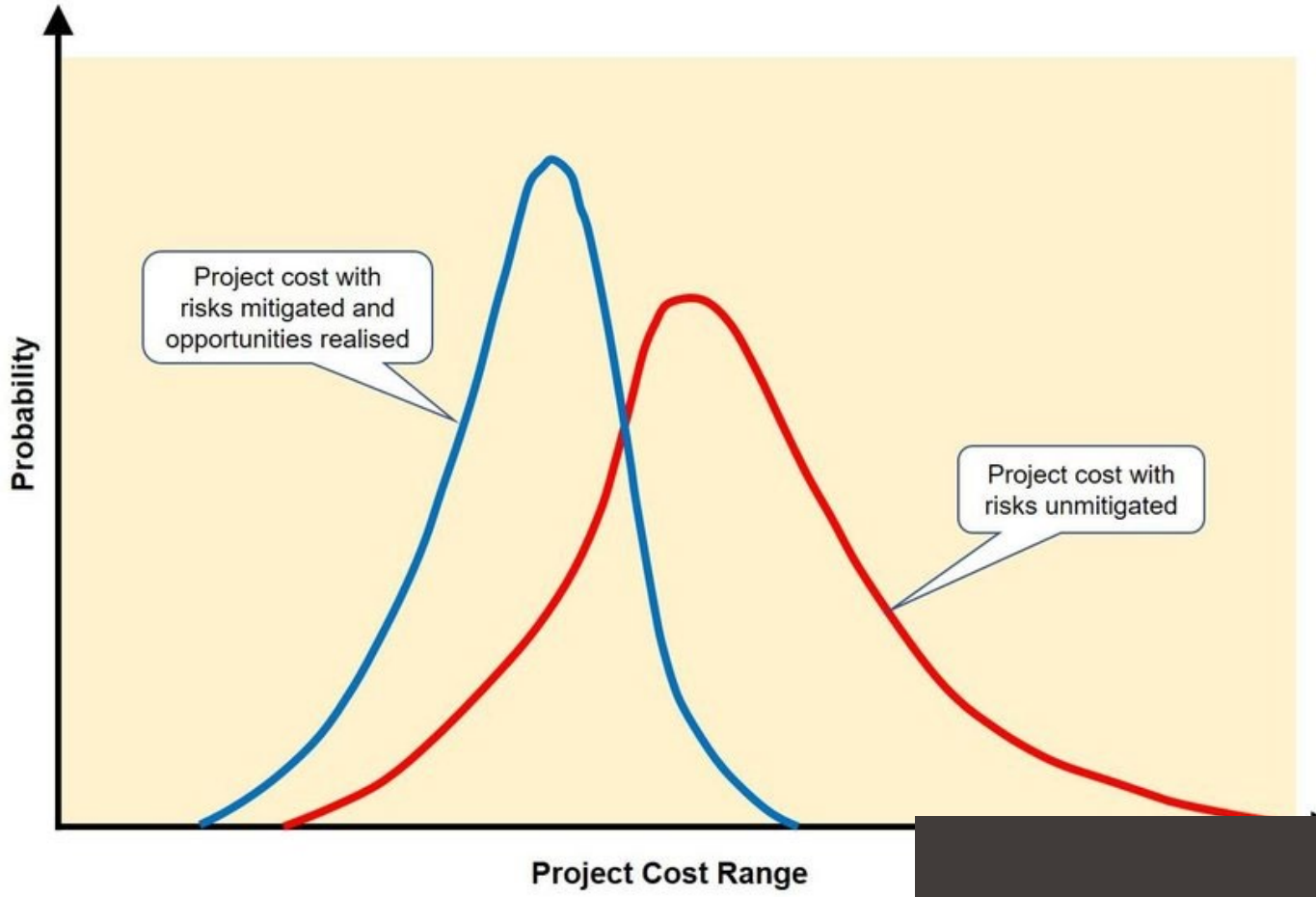

MODULE 3 :

Risk Reduction

ISIC-GSCP
Group of Chemical and Physical Safety

Source: https://www.researchgate.net/figure/Comparison-of-project-cost-estimates-before-and-after-risk-mitigation-Parsons_fig6_327981100

2025

Mitigation vs Reduction

Thierry Meyer

- Risk mitigation seeks to reduce the risks associated with an activity.

- Risk reduction may involve avoiding an activity entirely due to its high level of risk.

Introduction: Could we mitigate the risk ?

Risk reduction includes all strategies aimed at limiting risks and damages within a specific area.

Source: https://www.centraalbeheer.nl/

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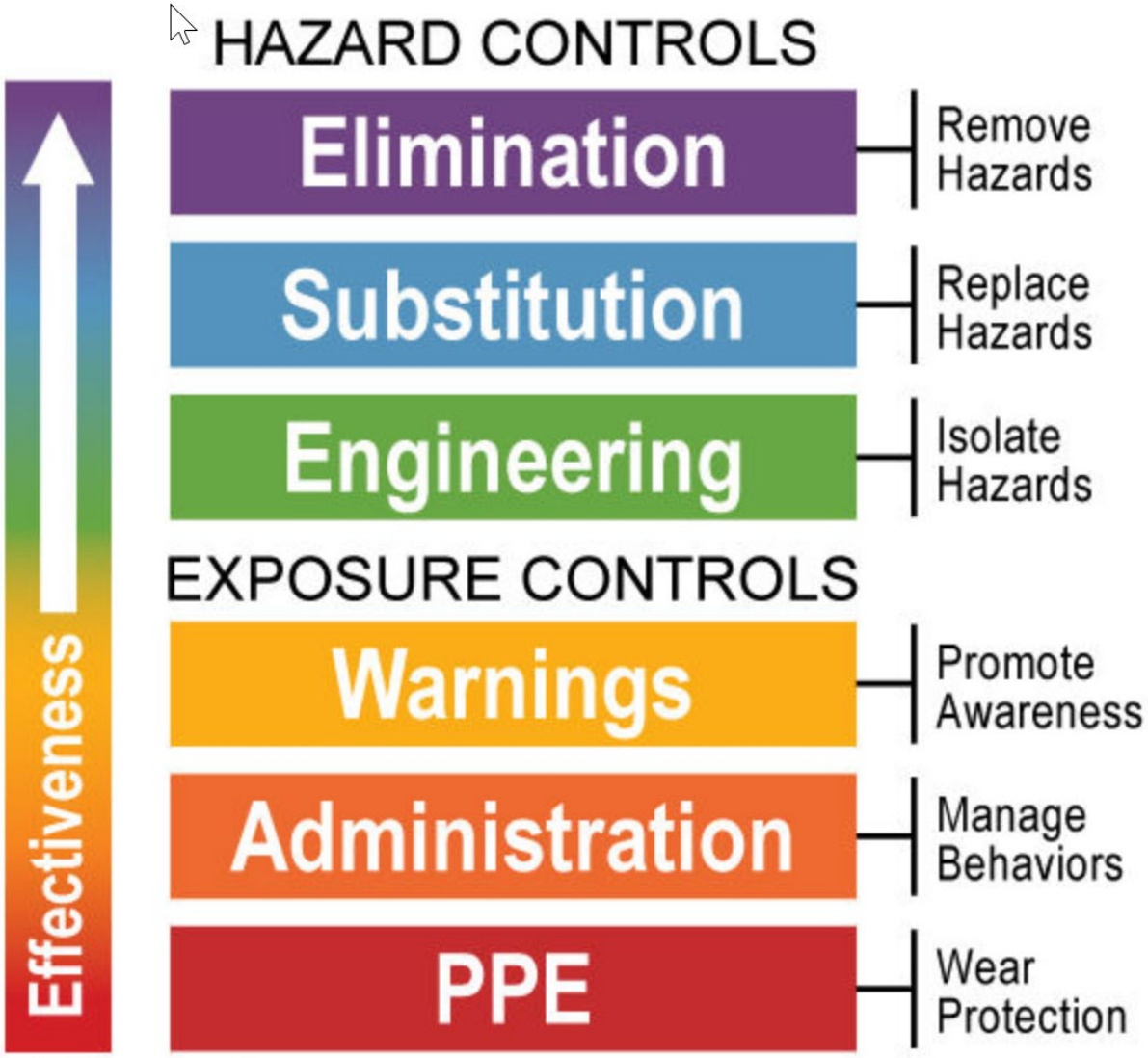
Module 3.1

Introduction

Introduction: Hierarchy of controls



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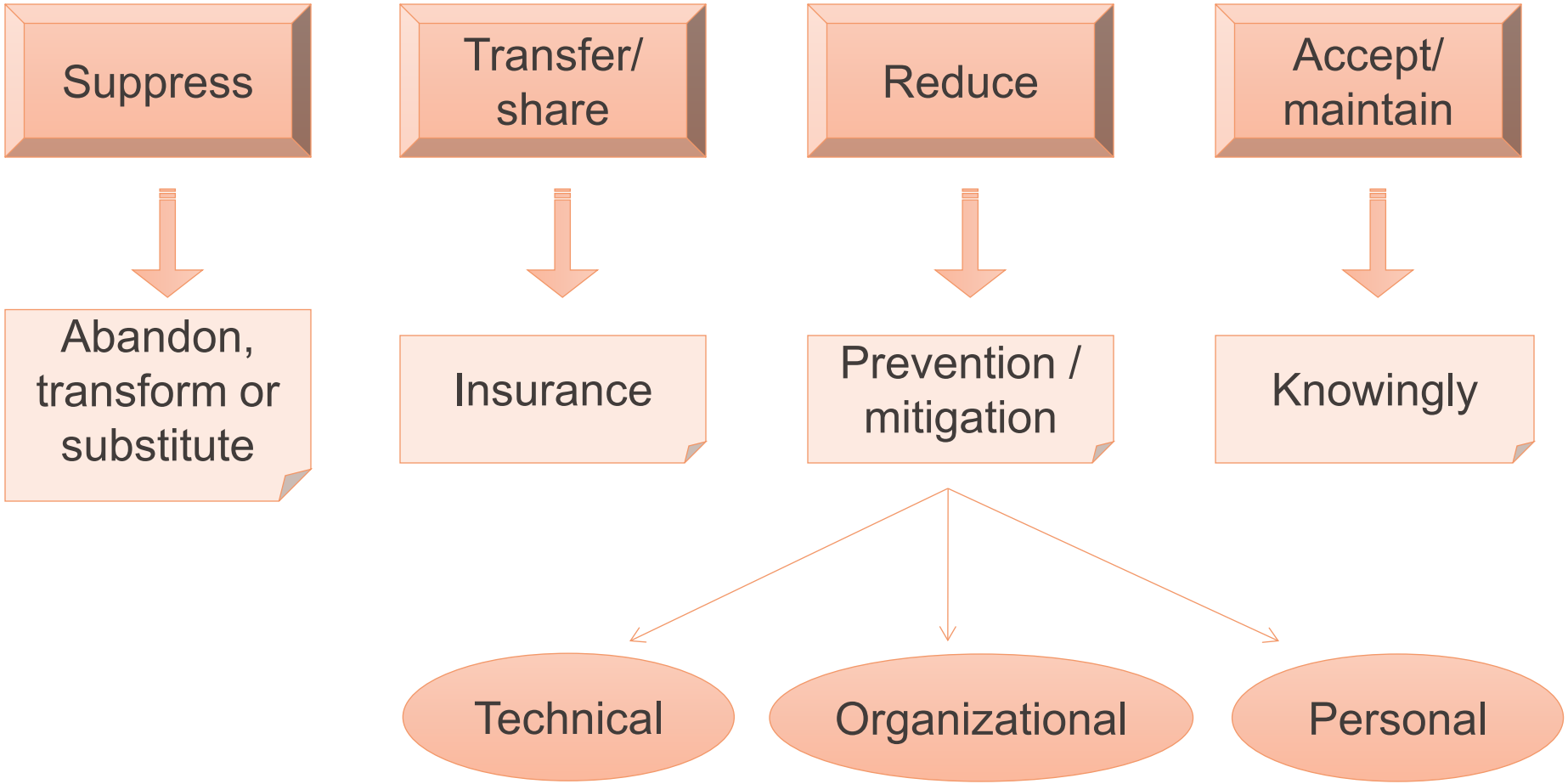
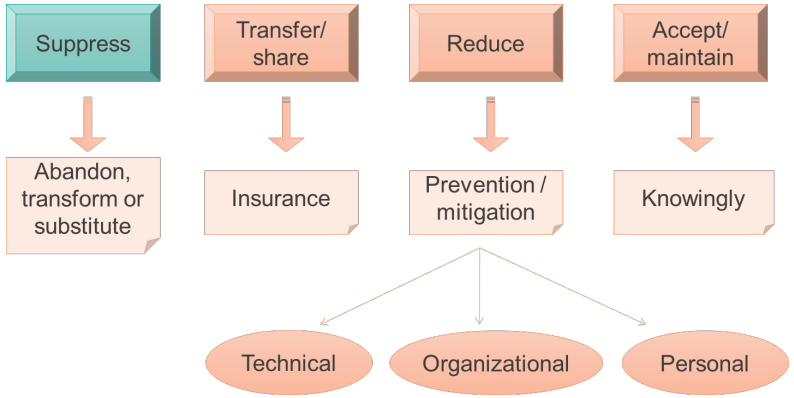
Risk management: Types of decisions



Suppress



Suppress or give-up

- If a risk is too significant to mitigate or accept, consider either:

1. Eliminating the process that causes the risk.
2. Modifying the process to reduce the level of risk.

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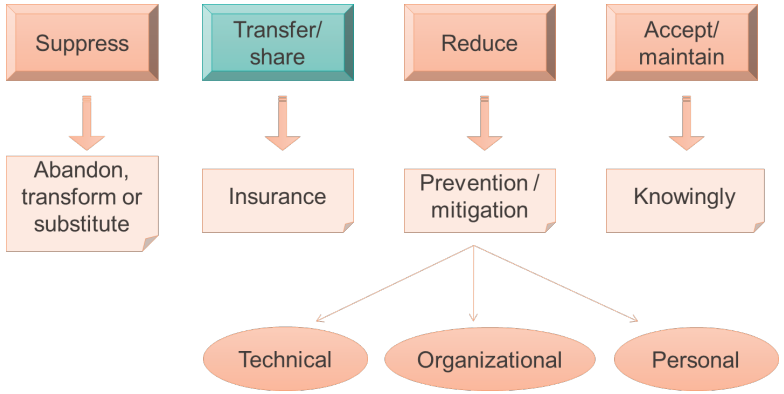
Transfer



Transfer options include:

- Insurance, which covers material damage through external or internal financing instruments.
- Subcontracting, which means resigning control (e.g., as seen in cases like “PIP”, Poly Implant Prothèses, where non-compliant gel was used to cut costs).

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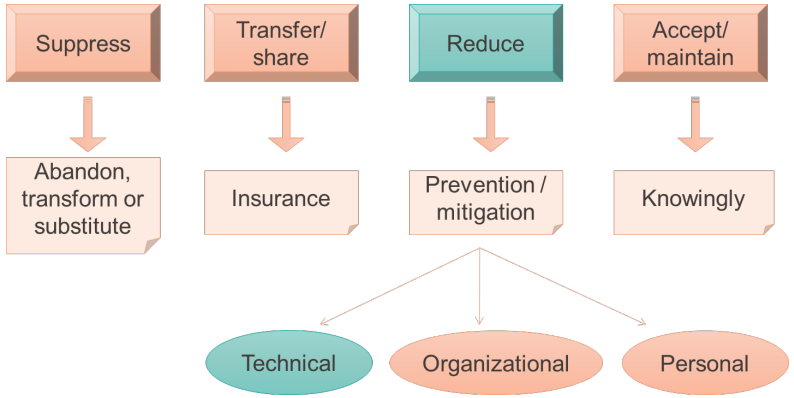
Technical measures



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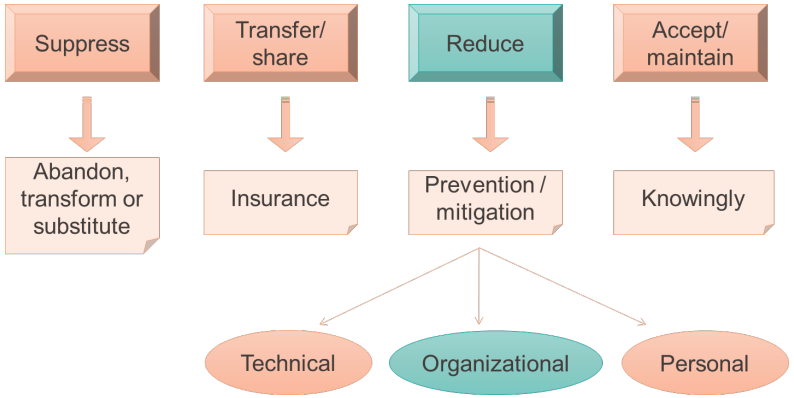
Poka-yoke

- **Definition**: Poka-yokes are mechanical devices designed to prevent human errors.
- **Medical Application**: In medicine, they help distinguish between different gas connections (like vacuum and oxygen in patient rooms, and oxygen and nitrous oxide in operating rooms) to enhance safety and accuracy.

Organizational measures



Information and communication

- Involve the act of conveying a message - whether through displays, gestures, or words - to confirm the recipient's understanding.

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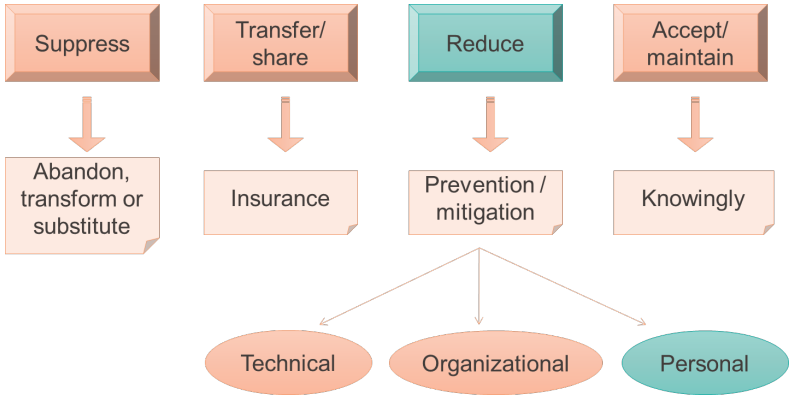
Personal measures



Personal protective equipment (PPE)

- Is worn to prevent contamination and may include:
  - Gloves
  - Coats
  - Masks
  - Protective goggles, when needed
  - …

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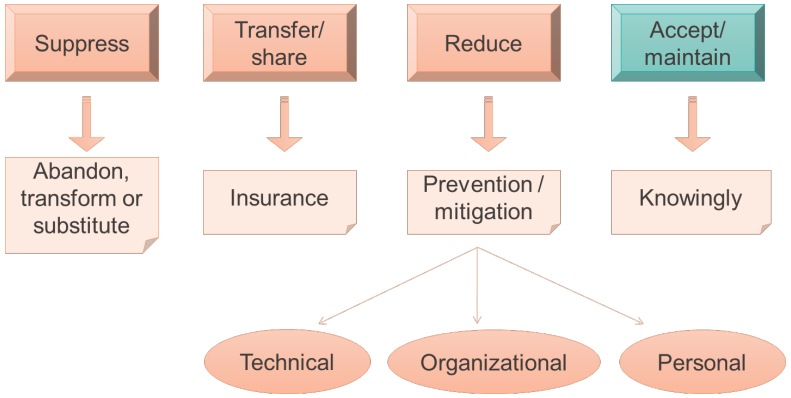
Acceptance of risk



- Accepting risk should be a last resort and must be done only after thoroughly understanding all relevant facts.
- Always assess potential consequences comprehensively before taking risky actions, considering impacts on both yourself and others.

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Source: https://www.hilti.co.uk

S.T.O.P.

STOP: Efficiency , STOP – source of hazard

Approach direction

	1. At the source	2. At the interface	3. At the target
Measures **S** (strategy/ substitution)	• Substitution • Change process	• Automation, telemanipulation • Room subdivision	• Selection criteria for certified operators
Measures **T** (technical)	• Production or use of reagents in continuous mode • Safety relieve valves	• A controlled fume extraction process • Physical access restrictions	• Selection and purchase of personal protective equipment PPE
Measures **O** (organizational)	• Response instructions	• Manually controlled smoke extraction • Marking of access restrictions	• Prescription for PPE • Organization of first-aid
Measures **P** (personal)	• Education / training of process staff	• Information / instruction on process hazards	• Instruction for the use of PPE

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STOP: Pros and cons of STOP measures

	Pros	Cons
Measures **S** (strategical/ substitution)	• Cancel or reduce the considered hazard • Intervene early in the process	• If substituted, additional hazards or risks may be created. • Elimination requires a strategic decision
Measures **T** (technical)	• Fixed • Difficult to bypass	• Costs • Deadlines
Measures **O** (organizational)	• Quick • Moderate costs	• Controllability • Easy to bypass
Measures **P** (personal)	• Quick • Moderate costs • Simple implementation	• Controllability • Acceptability • Convenience • Omission

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Introduction: Is the problem solved ?

Source: https://www.centraalbeheer.nl/

Time 40``

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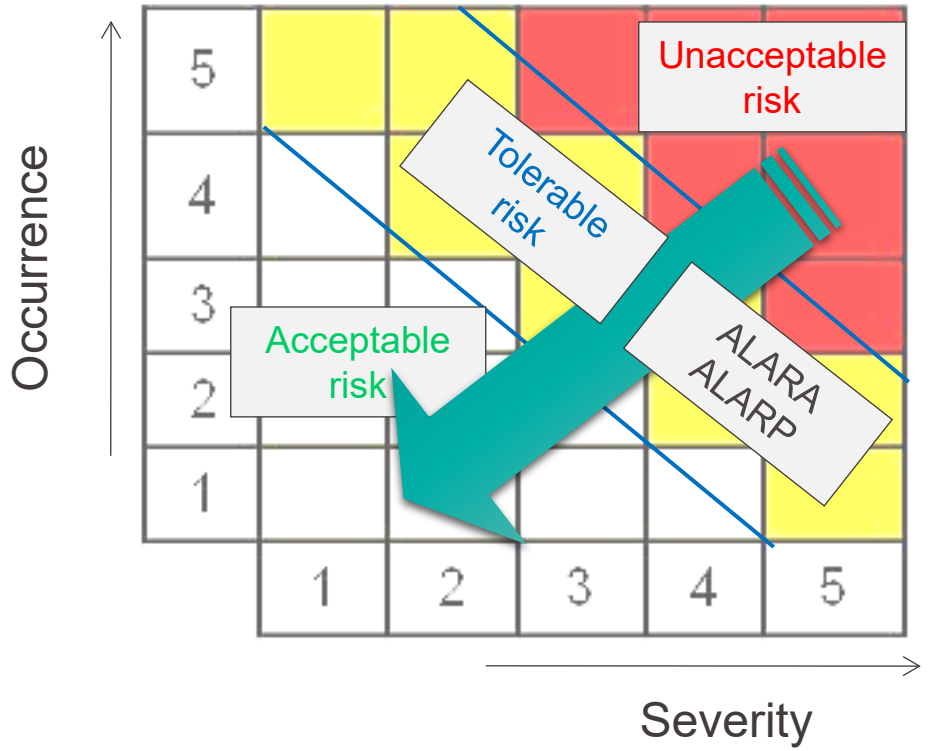
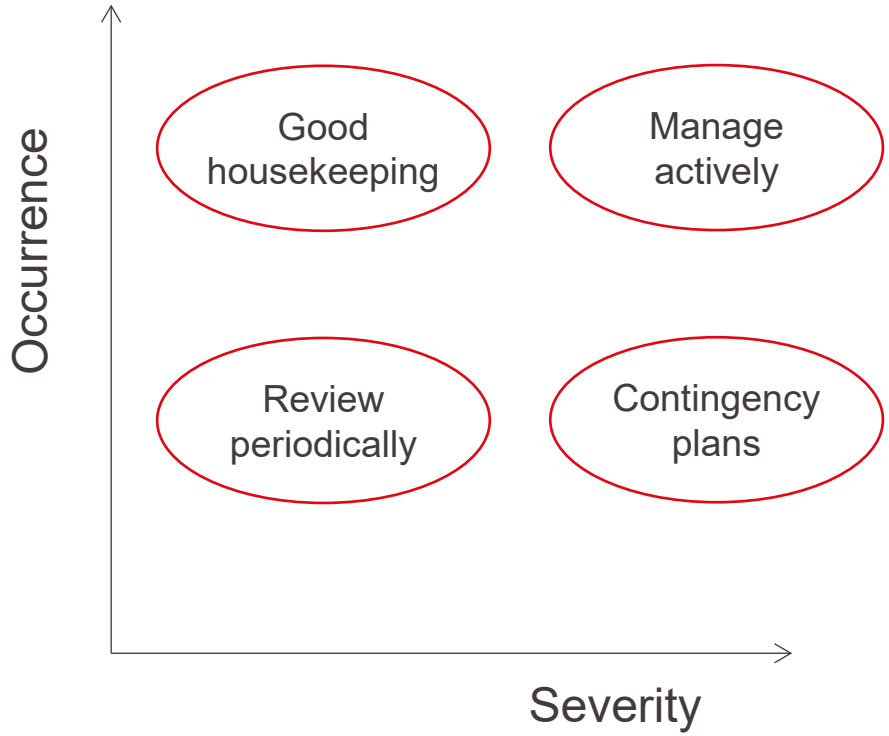
Introduction: Managing risks





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Source: https://safeoptionsolutions.com.au/gallery/Olden-Day-Construction

Introduction: Prevention (1)

- Preventive measures focus on the causal chain of losses, targeting specific points to prevent accidents.
  E.g. prohibiting smoking in a room with flammable materials.

- Effective preventive measures rely on a thorough analysis of root causes.

- Preventive measures are designed considering the cost-effectiveness and form the prevention plan.

Introduction: Prevention (2) – Eight principles

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1. Avoid and Assess Risks: Eliminate or manage hazards.
2. Prevent at the Source: Build prevention into processes and designs.
3. Adapt Work for Safety: Customize work conditions for workers.
4. Embrace Technology: Keep up with advancements.
5. Choose Safer Options: Prioritize less hazardous methods and materials.
6. Integrate Comprehensive Prevention: Include technical, organizational, and environmental aspects.
7. Prioritize Collective Protection: Collective measures over personal protective equipment.
8. Provide Worker Training: Equip employees for risk awareness and involvement.

Source: https://ip.com/blog/invention-personal-protective-equipment/

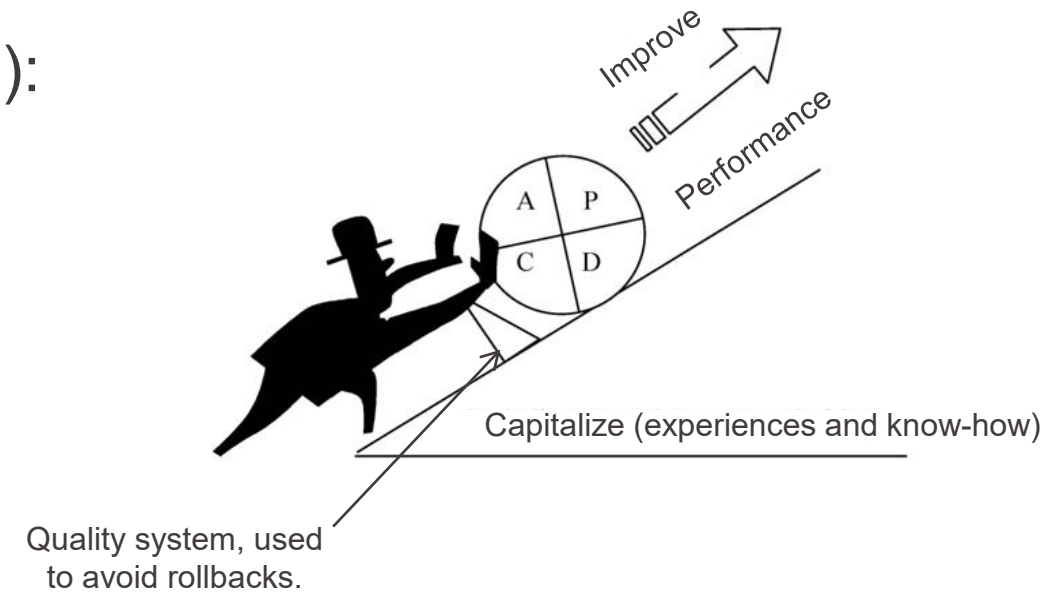
Introduction: Protection (1)

- Protection encompasses all measures that mitigate the consequences, severity, or progression of a disaster.
- There are two types of protection measures (safeguards):
  - Before (pre-)event: *reduce the size or impact of the risk exposure when an event does take place.*
  - After (post-)event: *are typically emergency actions taken after the event to halt the accumulation of damage or counteract the effects of the disaster.*
- Using the example of fire protection:
  - Building firewalls = passive protection.
  - Establishing a system for detection and/or sprinkler = active protection.
  - Establish an evacuation plan + drills = active protection.
- Remedial actions, considering added costs versus existing risks, form the emergency plan along with preparedness measures.

Management: Anticipation - Reaction

- Management by reaction:
  - A situation gradually worsens until it becomes unbearable.
  - Then, substantial resources are quickly allocated to remedy the situation.
  - The cycle then repeats.

- Management by anticipation (proactive):
  - Set up a monitoring system to promptly address any deterioration with corrective actions.
  - Anticipate possible deterioration by implementing preventive measures.



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Introduction: SEVESO I, II and III directives

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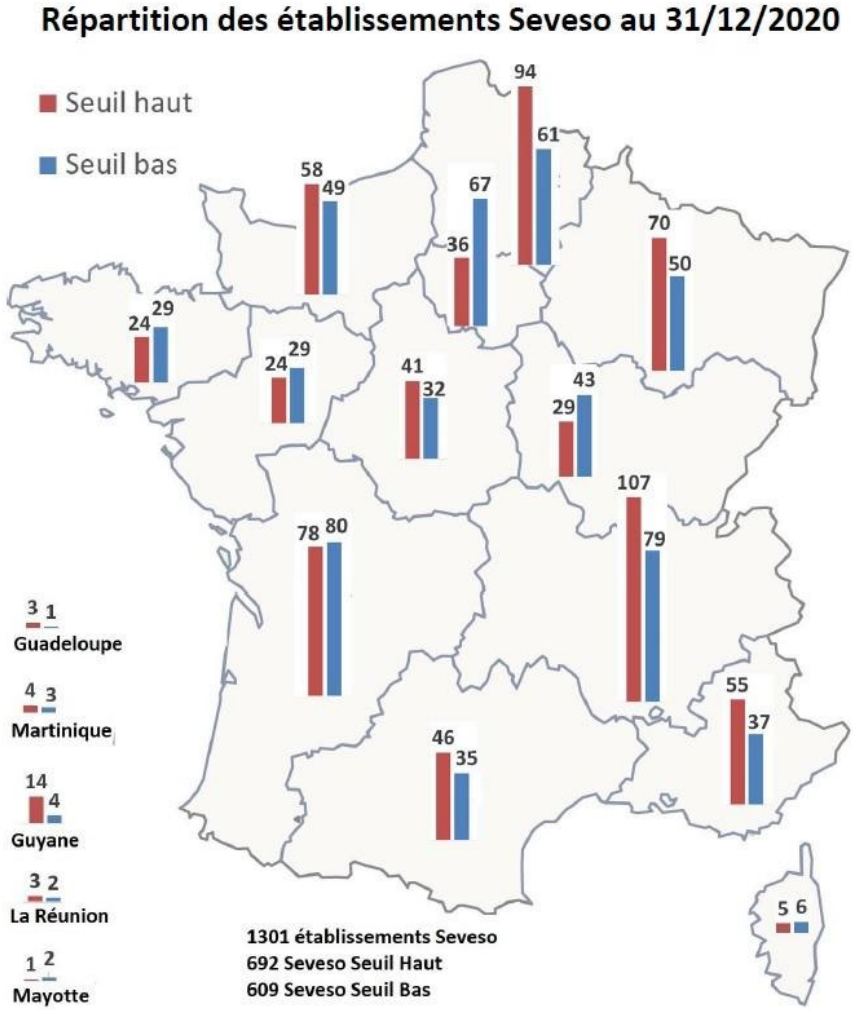
- Following the 1976 Seveso dioxin release incident, European states implemented the SEVESO directive to control major-accident hazards related to dangerous substances.
- The directive, updated in 1999, 2003 (SEVESO II), and 2012 (SEVESO III), emphasizes the need for a Safety Management System tailored to the risks of each industrial plant for preventing major accidents.
- It aims to prevent major accidents caused by certain industrial activities and minimize their impact on health and the environment.
- Sites are classified as "Seveso" based on the types and quantities of hazardous materials they handle.

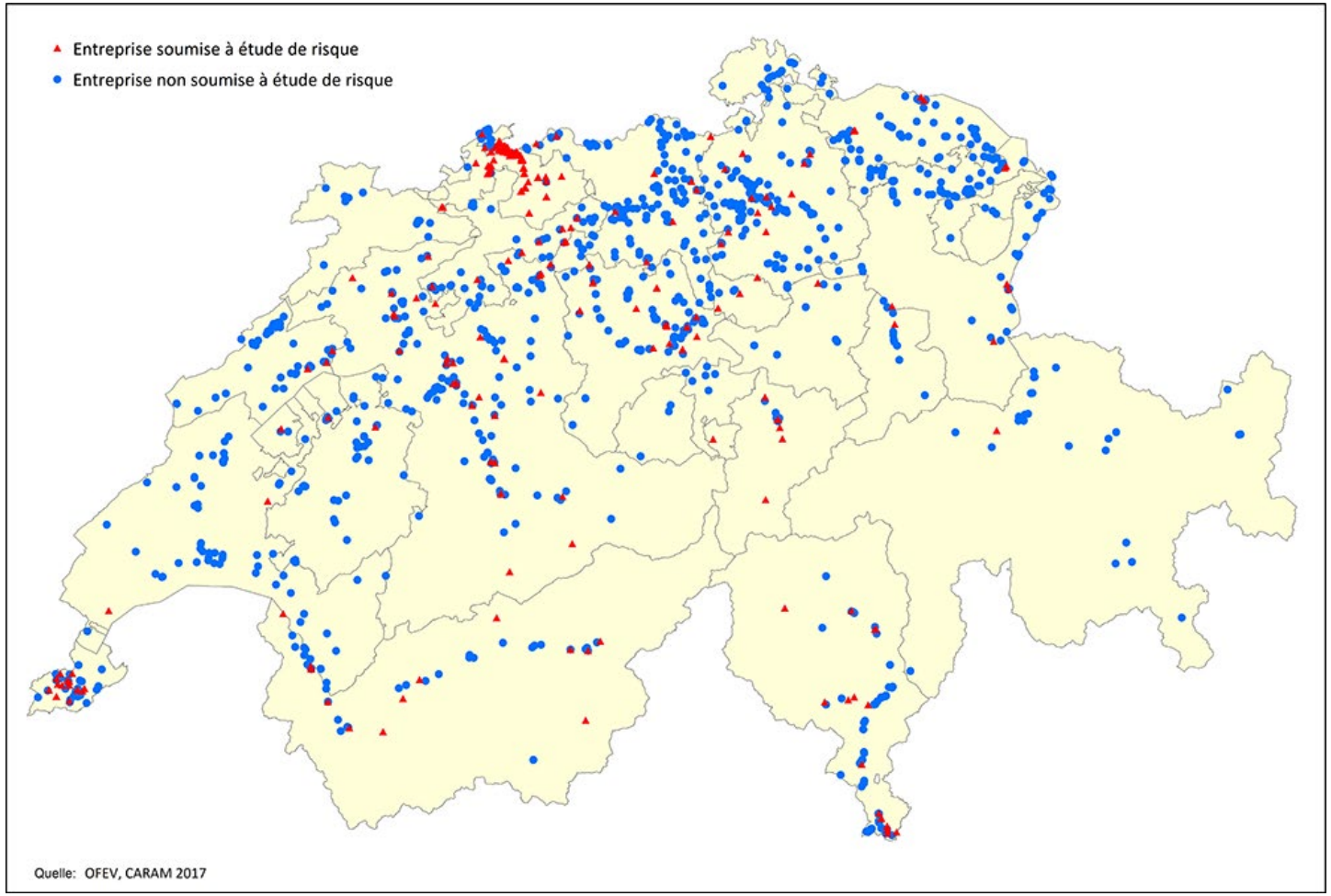
Introduction: SEVESO III sites in France



Source: Ministère de la Transition écologique et solidaire, France
https://www.ecologique-solidaire.gouv.fr/risques-technologiques-directive-seveso-et-loi-risques#e2

Industrial sites classified Seveso III in France in 2020. A total of 1301 sites are listed, 53% are classified Seveso high and 47% Seveso low.

Introduction: Chemical hazards in Switzerland



Source: Federal Office for the Environment OFEV, DETEC
https://www.bafu.admin.ch/bafu/fr/home/themes/accidents-majeurs/etat/cartes.html

Spatial distribution of 1300 companies subject to the law on major accidents due to dangerous chemical potential, 2017.

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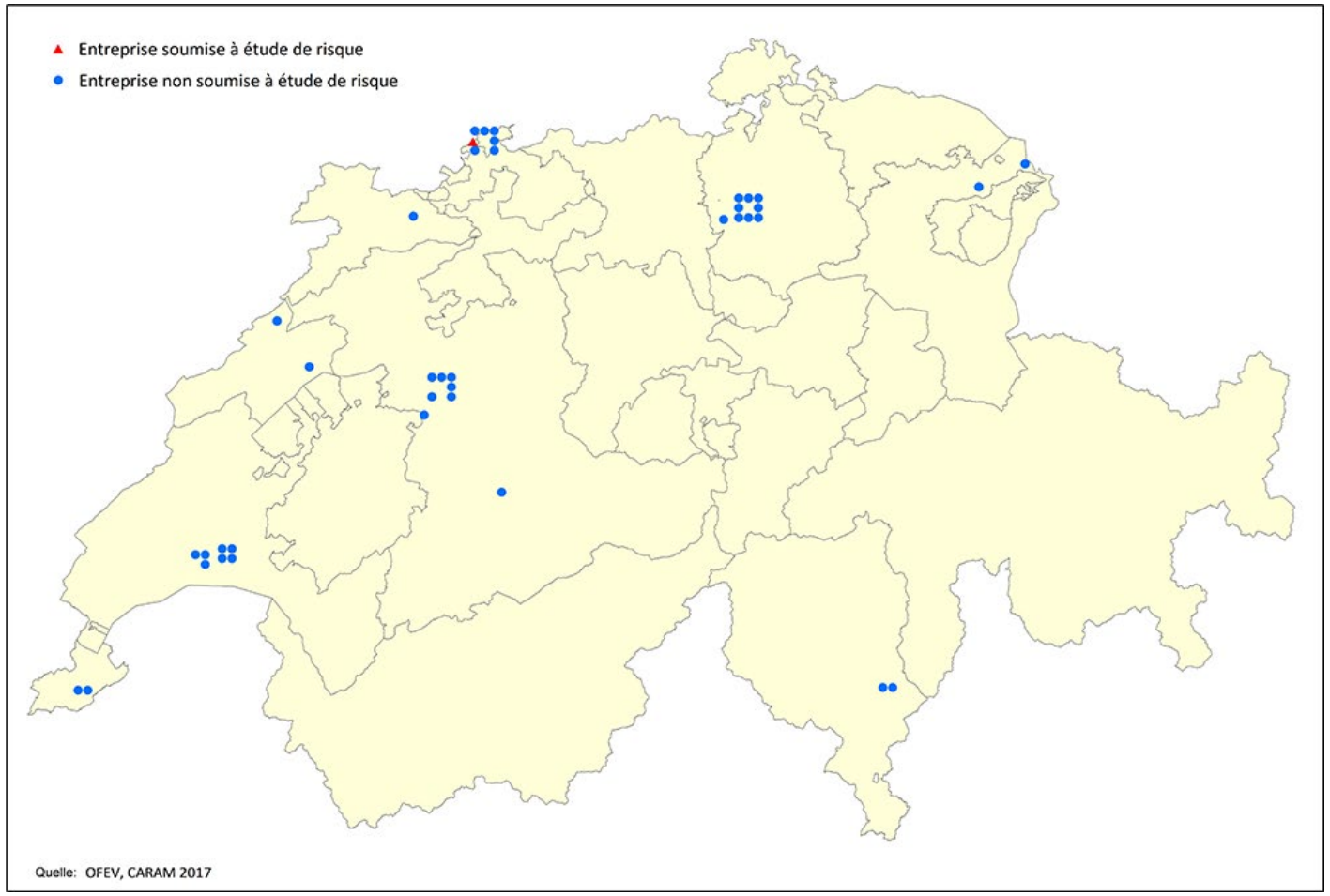
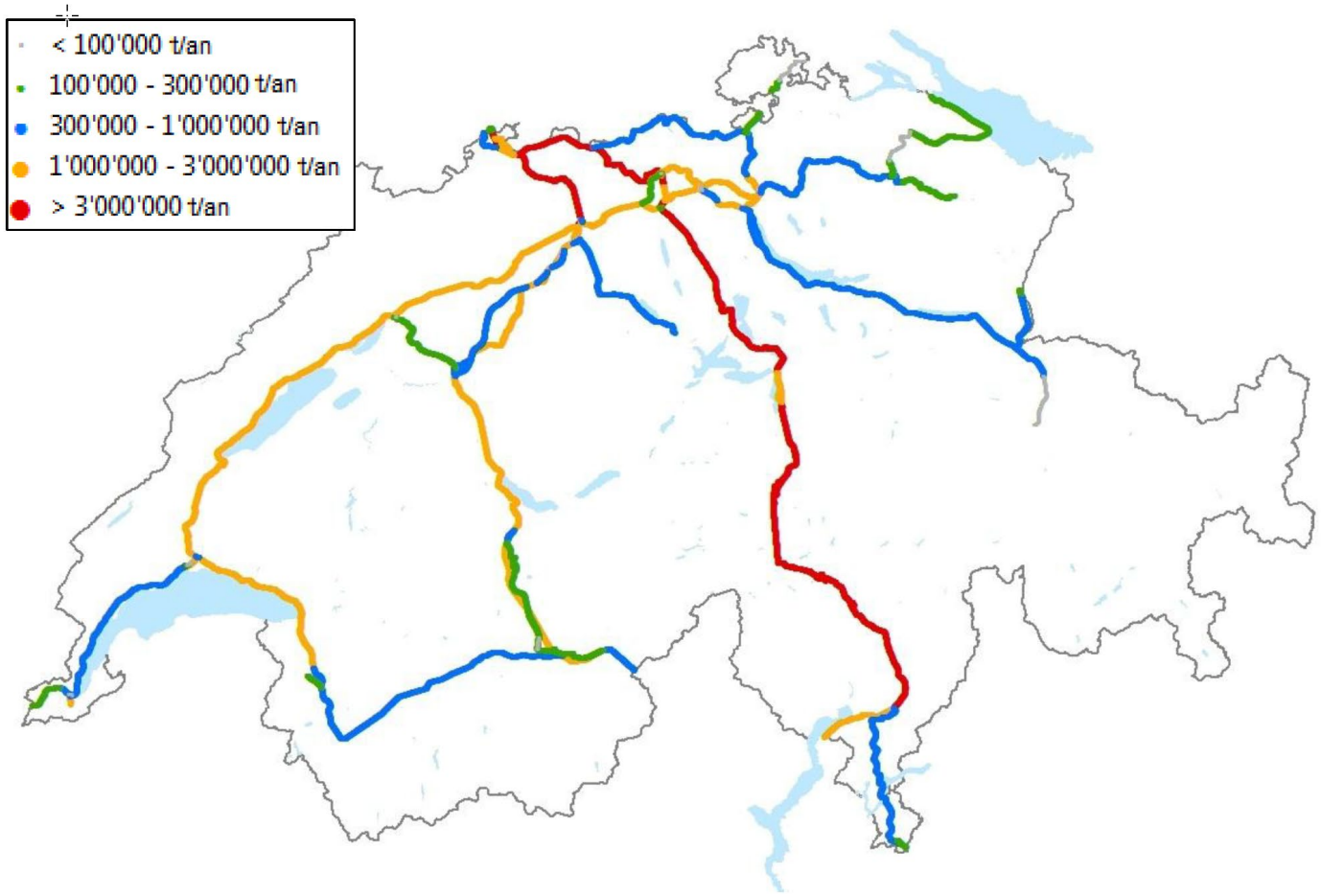
Introduction: Bio-hazards in Switzerland



Source: Federal Office for the Environment OFEV, DETEC
https://www.bafu.admin.ch/bafu/fr/home/themes/accidents-majeurs/etat/cartes.html

Spatial distribution of companies subject to the law on major accidents due to biohazard level 3 and 4, 2017. (source Federal Office for the Environment OFEV, DETEC)

Introduction: Transport of dangerous goods, in CH



Source: Federal Office of Transport, OFT, DETEC
https://www.bav.admin.ch/bav/fr/home/publications/rapports/stoerfallvorsorge/screening-des-risques-pour-l-environnement.html

Transport of dangerous goods in 2013 by train (cumulative net tonnage without weighting for all dangerous goods). Updated 2023.

Introduction: Transport of dangerous goods (train), in CH

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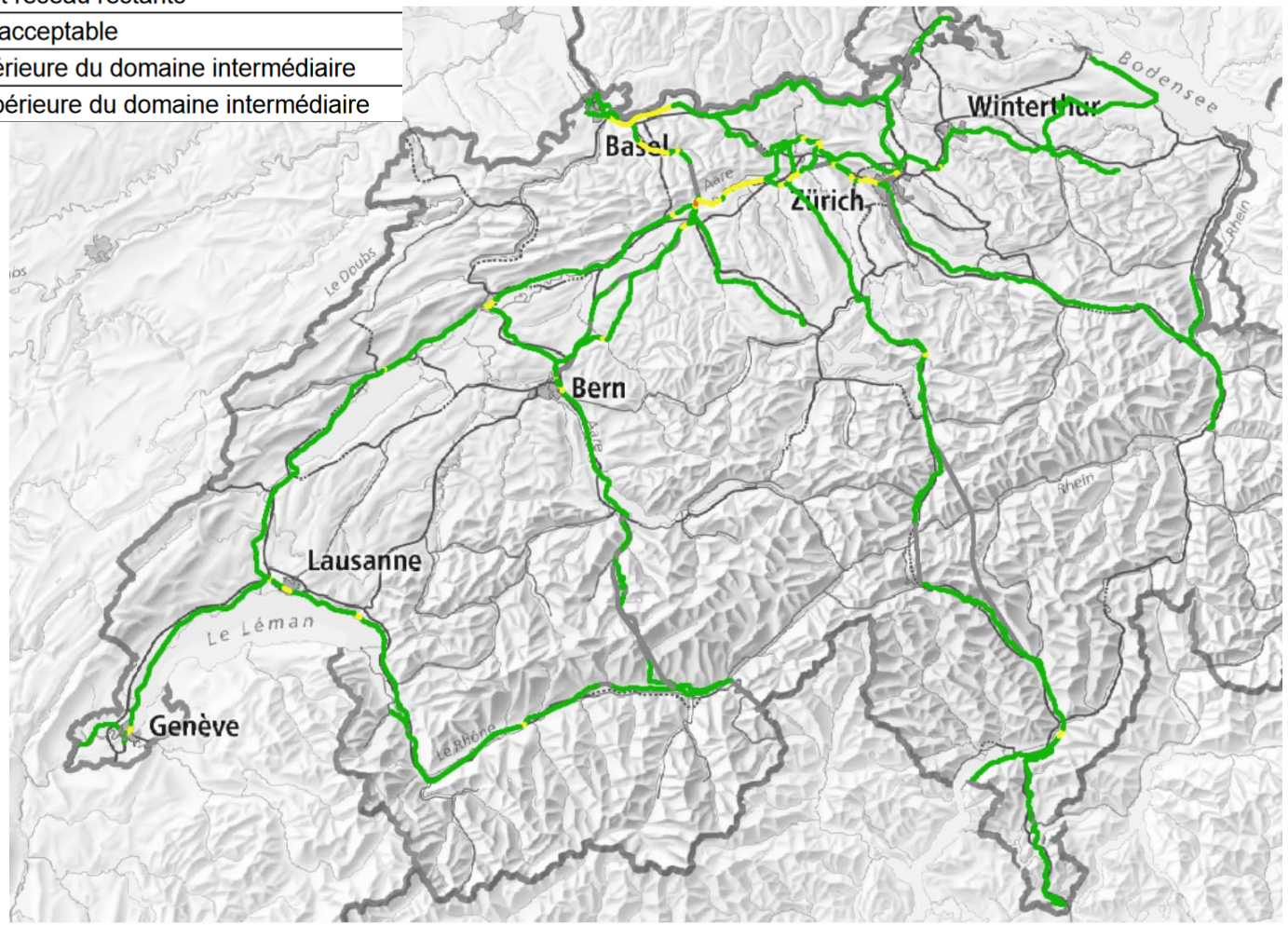
	Tunnels et réseau restants
	Domaine acceptable
	Moitié inférieure du domaine intermédiaire
	Moitié supérieure du domaine intermédiaire



Source: Federal Office of Transport, OFT, DETEC
file:///C:/Users/tmeyer/Downloads/f-Ergebnisbericht_P-und_U-Risiken_2018_f.pdf

Transport of dangerous goods by train in 2018, overview of risks to the population for all representative substances

Module 3.2

Risk Treatment

Risk treatment: Introduction

Thierry Meyer

- The risk treatment phase is central to risk management, allowing organizations to actively mitigate the risks they face.
- In this phase, actions are taken to address the hazards, vulnerability of the environment, or both, wherever feasible.
- It involves identifying, selecting, and implementing measures to reduce risks to an acceptable level.
- Risk treatment involves three specific steps:
    1. Identifying potential measures in prevention, preparedness, response, and recovery.
    2. Evaluating and selecting the most appropriate measures.
    3. Planning and implementing the selected measures.

Risk treatment: According to ISO/IEC 27001: 2022

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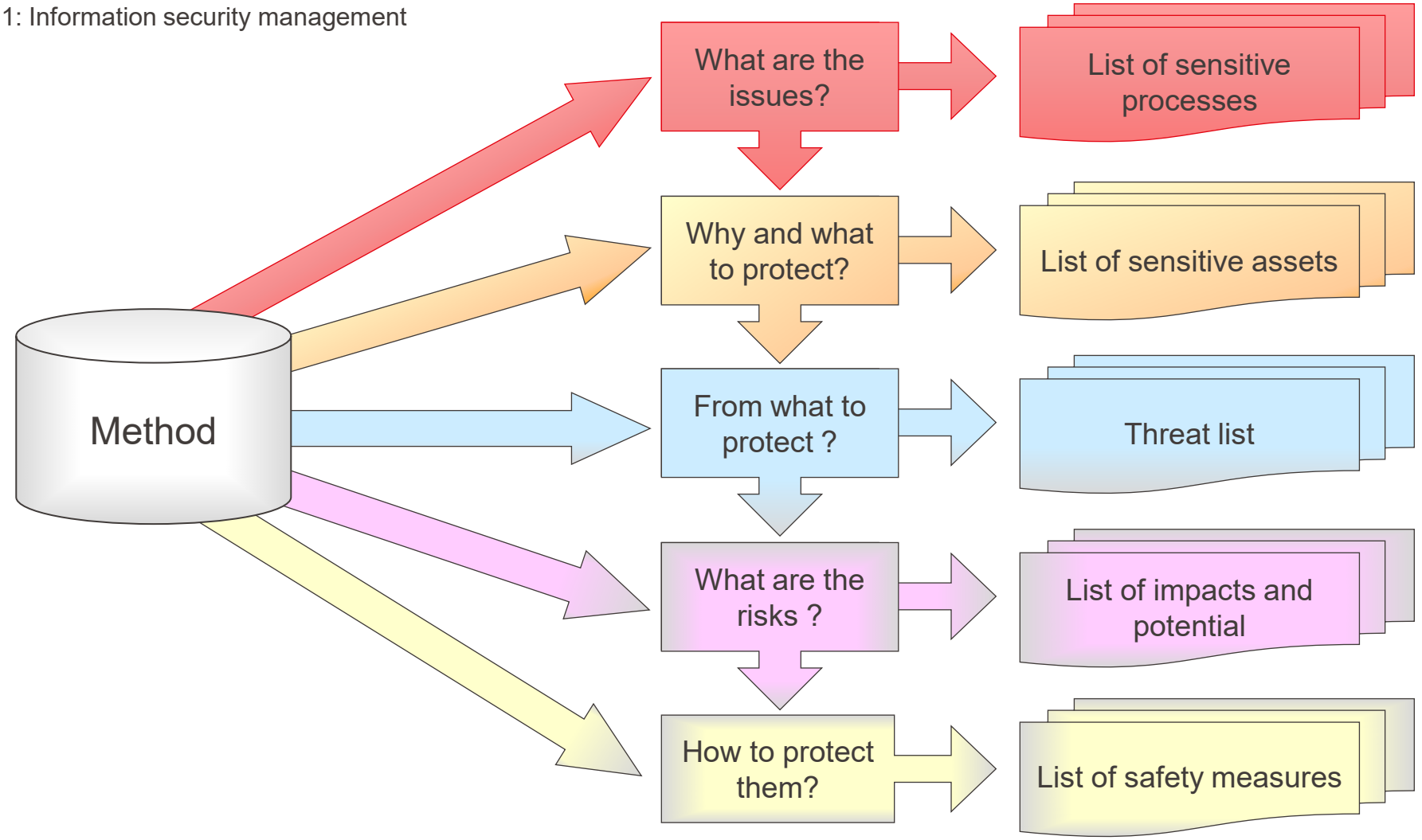
ISO/IEC 27001: Information security management



Risk treatment: the questions

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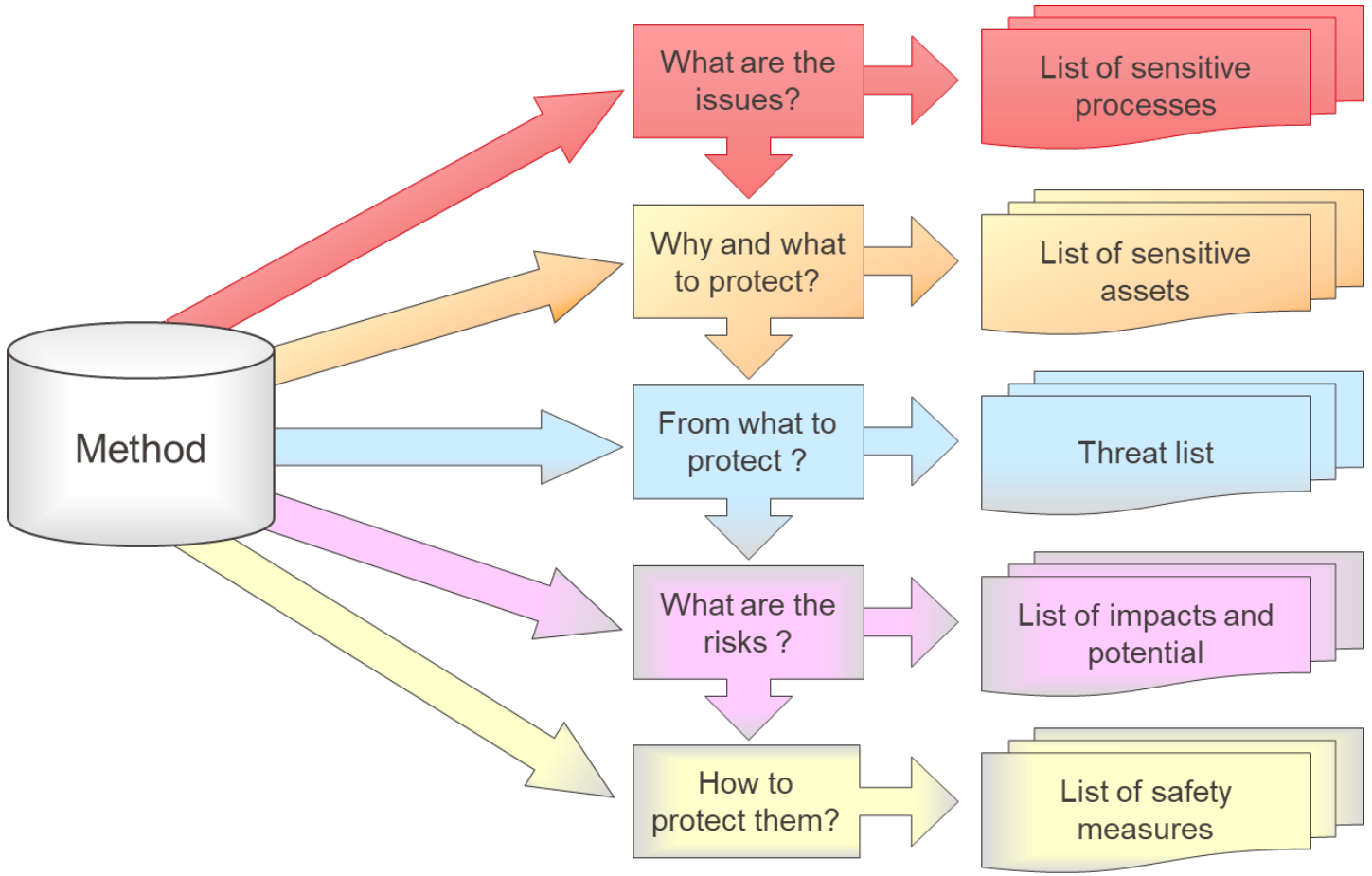


Choose a sensitive process?

What needs protection as a priority?

What are the potential risks or issues that could arise?

Have you thoroughly assessed the risks you may be exposed to?

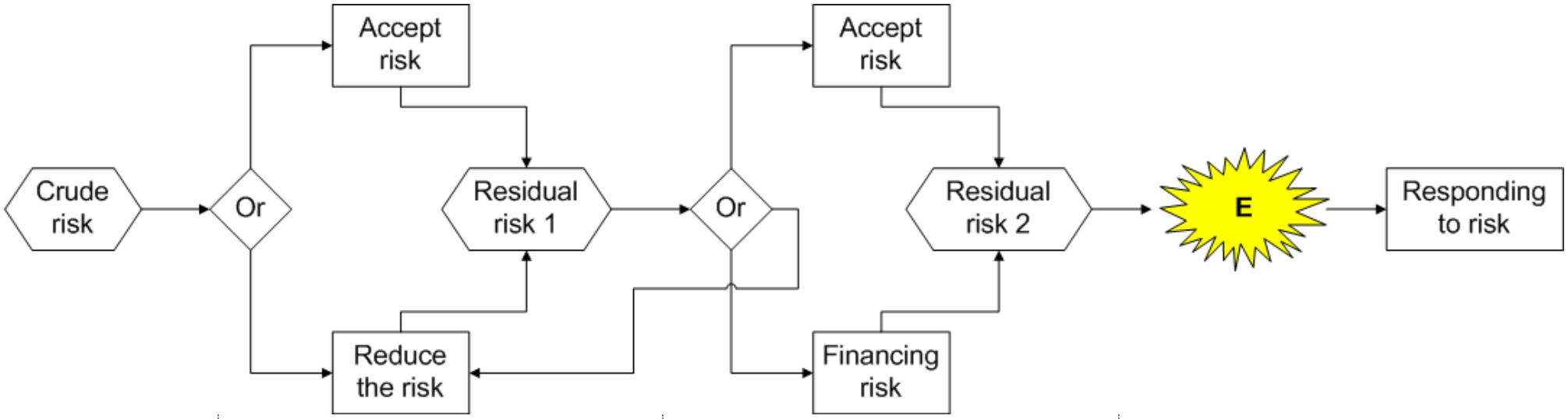
What measures have you established to avoid or minimize potential impacts?

Risk treatment: The process

3 steps

2 questions:

- Is the risk acceptable ?
- Should the risk be reduced ?



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Risk treatment: Precautionary principle (1)

- The precautionary principle, as stated in the Rio Declaration of 1992, places the burden of proof on those advocating for an action or policy that carries a suspected risk of harm to the public or the environment when there is no scientific consensus confirming its safety. This principle emphasizes the need for caution in such situations.
- The precautionary principle empowers policymakers to act in cases of potential harm even without complete scientific proof, prioritizing proactive measures for public health and the environment.
- The principle implies that there is a responsibility to intervene and protect the public from exposure to harm where scientific investigation discovers a plausible risk in the course of a screening for other suspected causes.
- Many definitions of the precautionary principle exist. Precaution may be defined as "*caution in advance*," "*caution practiced in the context of uncertainty*," or "*informed prudence*".
- The precautionary principle is meant to apply when, based on the best available scientific advice or scientific uncertainty, there are substantial grounds to suspect that harmful effects could occur.

Risk treatment: Precautionary principle (2)

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The precautionary principle defined in the Regulation (EC) No 178/2002 of the European Parliament and of the Council, section 1 article 7:

1. In specific circumstances where, following an assessment of available information, the possibility of harmful effects on health is identified but scientific uncertainty persists, provisional risk management measures necessary to ensure the high level of health protection chosen in the Community may be adopted, pending further scientific information for a more comprehensive risk assessment.

2. Measures adopted on the basis of paragraph 1 shall be proportionate and no more restrictive of trade than is required to achieve the high level of health protection chosen in the Community, regard being had to technical and economic feasibility and other factors regarded as legitimate in the matter under consideration. The measures shall be reviewed within a reasonable period of time, depending on the nature of the risk to life or health identified and the type of scientific information needed to clarify the scientific uncertainty and to conduct a more comprehensive risk assessment.

Risk control: Method -1-

- If a risk assessment indicates that the current work system is unsafe or the risk level is unacceptably high, actions must be taken to eliminate or reduce the risk.
- Once measures are implemented, it's crucial to reassess the risk to ensure the measures are effective in reducing it.
- Additionally, any new protective measures should be evaluated for potential side effects or the emergence of new hazards.

RESIDENTS of a sleepy Scottish village are being driven round the bend – by wiggly white lines painted on the road.

The loopy lines were meant to be a traffic-calming measure on the A811 in Arnprior, Stirlingshire. But they're having the opposite effect on motorists.

Councilor Ian Muirhead said: "In common with many residents, I find the wiggly lines to be not only ineffective but also look stupid.

"They were put in place as a supposed traffic-calming measure by Stirling Council. I think the idea is that people see the wobbly lines and assume it's going to be a bumpy road so they slow down.

"But many people have said it just looks like the lines were painted by a drunken road worker."

Oct 26, 2013 By Dailyrecord.co.uk

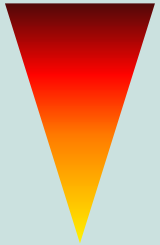
Traffic-calming measure on the A811 near Arnprior, Stirlingshire, Scotland
Source: https://www.dailyrecord.co.uk/news/scottish-news/

Risk control: Method -2-, prevention organization

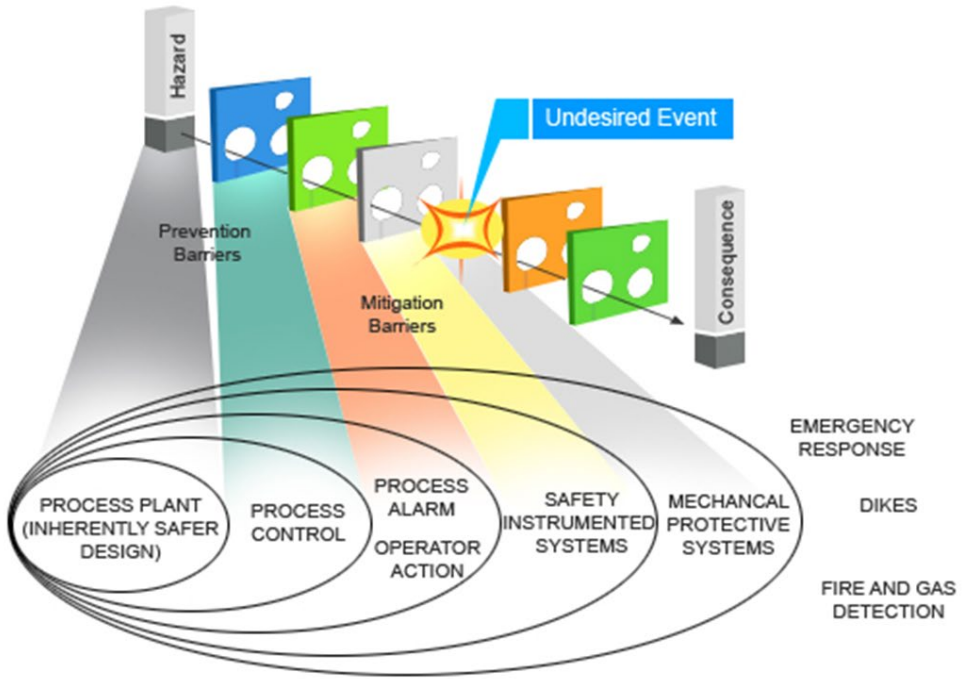
Thierry Meyer

The selection of preventive actions aligns with the hierarchy corresponding to the exposure process:

1. Prioritize measures that restrict the use or release of harmful agents.
2. Implement measures to prevent the dispersion of these agents to workers.
3. Lastly, consider personal protective measures when necessary.

Exposure process		Priority of preventive actions
1. Emission		1. At the source of hazard
2. Transmission in the environment of the target		2. At the interface between the target and the source.
3. Exposition		3. At the target

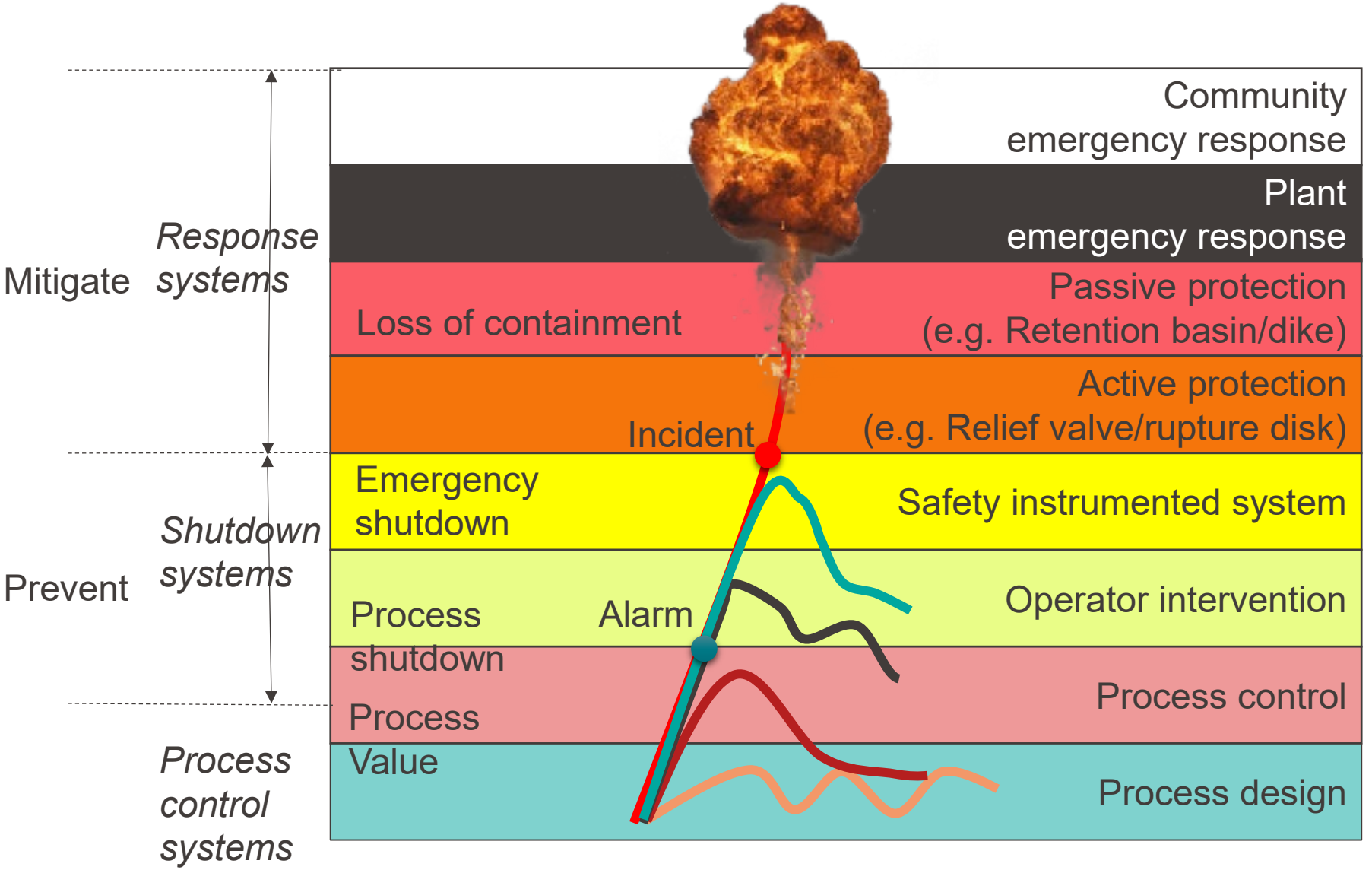
Risk control: Method -3-, layers of protection (1)



- Layer of Protection Analysis (LOPA) is a semi-quantitative risk assessment based on hazard scenarios. It estimates the likelihood and severity of risks by assessing protective layers.
- LOPA aims to identify the scenarios with the highest risk and assess whether applying inherently safer design principles can reduce the potential consequences of these scenarios.

IEC: International Electrotechnical Commission (170 countries)
ISA: International Society of Automation (mainly USA)

Risk control: Method -3-, layers of protection (2)



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Risk control: Method -3-, layers of protection (3)

- LOPA is also employed to determine whether safety instrumented systems (SIS) or other protection layers are necessary to enhance process safety.
- LOPA focuses on understanding how a process deviation could lead to a hazardous outcome unless interrupted by an effective safeguard, known as an Independent Protection Layer (IPL).
- Safeguards can be classified as active, passive, or human-based.

Source: https://www.c-value.dk/lean-5s

Module 3.3

5 S

5 S: Methodology (1)

- 5S method: Derived from the Toyota Production System (TPS).
- Involves five steps: Seiri, Seiton, Seiso, Seiketsu, Shitsuke.
- Organizes the workspace for efficiency and effectiveness.
- Promotes employee ownership of the process.
- Enhances safety and efficiency, indirectly contributing to risk reduction.

Source: https://www.logistiek.nl/warehousing

Thierry Meyer

5 S: Methodology (2) - explanation

Thierry Meyer

Sort	Set in Order	Shine	Standardise	Sustain
When in doubt, move it out – Red tag technique	A place for everything and everything in its place	Clean and inspect or inspect trough cleaning	Make up the rules, follow and enforce them	Part of daily work and it becomes a habit

Source: https://gemwellmachine.com/news/

5 S: Methodology (3) - Example in industry

Programme 5S

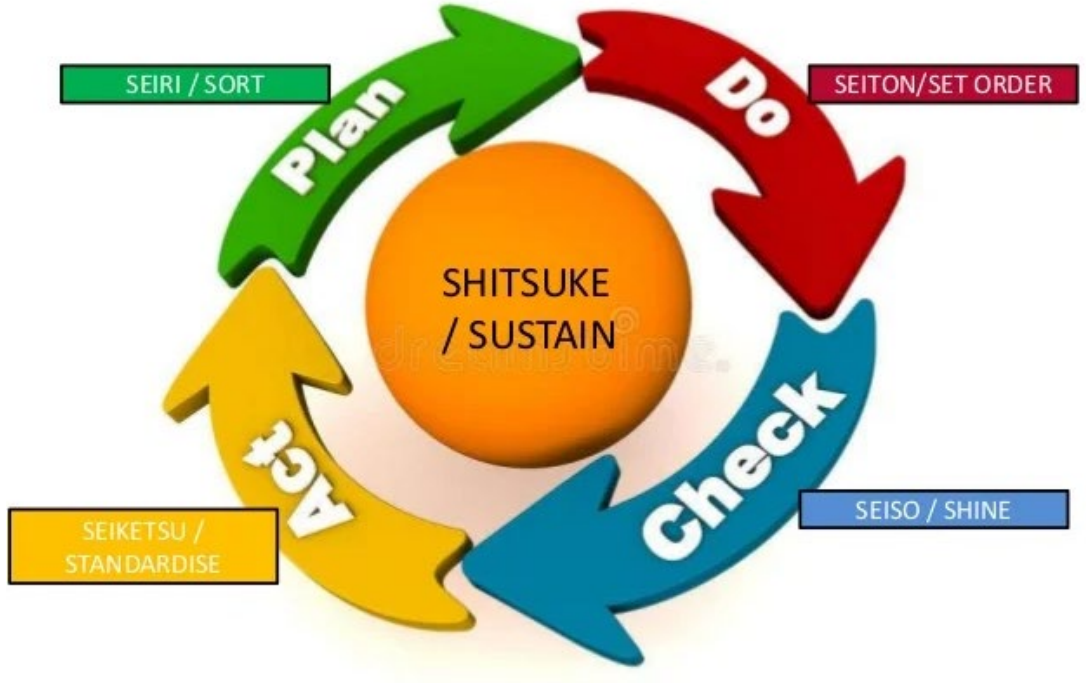
1°S	Trier/ Éliminer *Seiri* *Sort*	L'INUTILE NE SERT A RIEN	
2°S	Ranger *Seiton* *Set in order*	CHAQUE CHOSE A SA PLACE UNE PLACE POUR CHAQUE CHOSE	
3°S	Nettoyer *Seisi* *Shine*	NETTOYER C'EST CONTRÔLER Éliminer les déchets, la saleté et les objets inutiles	
4°S	Formaliser *Shekitsu* *Standardize*	C'EST L'ACTION DE «STANDARDISER» Formaliser les bonnes pratiques par des méthodes de travail	
5°S	Rigueur et suivi *Shitsuke* *Sustain*	PERPÉTUER ET PROGRESSER Communiquer le «5S» Donner du temps pour le «5S»	

Courtesy: Huntsman Advanced Materials LLC

5 S: Methodology (4) - Application to QSE

	Safety	Environment	Quality
Seiri **Sort**	• Remove obstacles in pathways, identify position, improving visibility. • Reduce the risk of falling objects and people.	• Remove anything that is not useful for the job, but which may present a risk in case of fire or leakage, etc…	• Eliminate the risk of errors and confusion. • To work in an adequate workplace. • To have only what is necessary in the workplace.
Seiton **Set in order**	• Identify potential hazards. • Set in order safely (no risk of falling or injury).	• Place items in appropriate locations and visible tanks, explosion-proof cabinets., etc.. • Identification of products.	• Remove the risk of errors and confusion.
Seiso **Shine**	• Early detection and remediation of damage.	• Limit the use of heavy equipment, aggressive detergents and solvents for spot cleaning.	• Clean base for quality work. • Prevention of defects. • Remedy any damage.
Seiketsu **Standardize**	• The rules are established, discipline applies to all.	• The existence of rules reduces irresponsible and disrespectful behavior.	• 5S are integrated into all procedures and rules governing the work and affecting its quality.
Shitsuke **Sustain**	• The introduction of stricter regulations and requirements in terms of safety and respect for the environment requires a permanent adaptation of rules and behaviors in companies.		• Maintaining the quality of products and services and the quality of the work environment are linked. • Continuous improvement is a requirement of ISO.

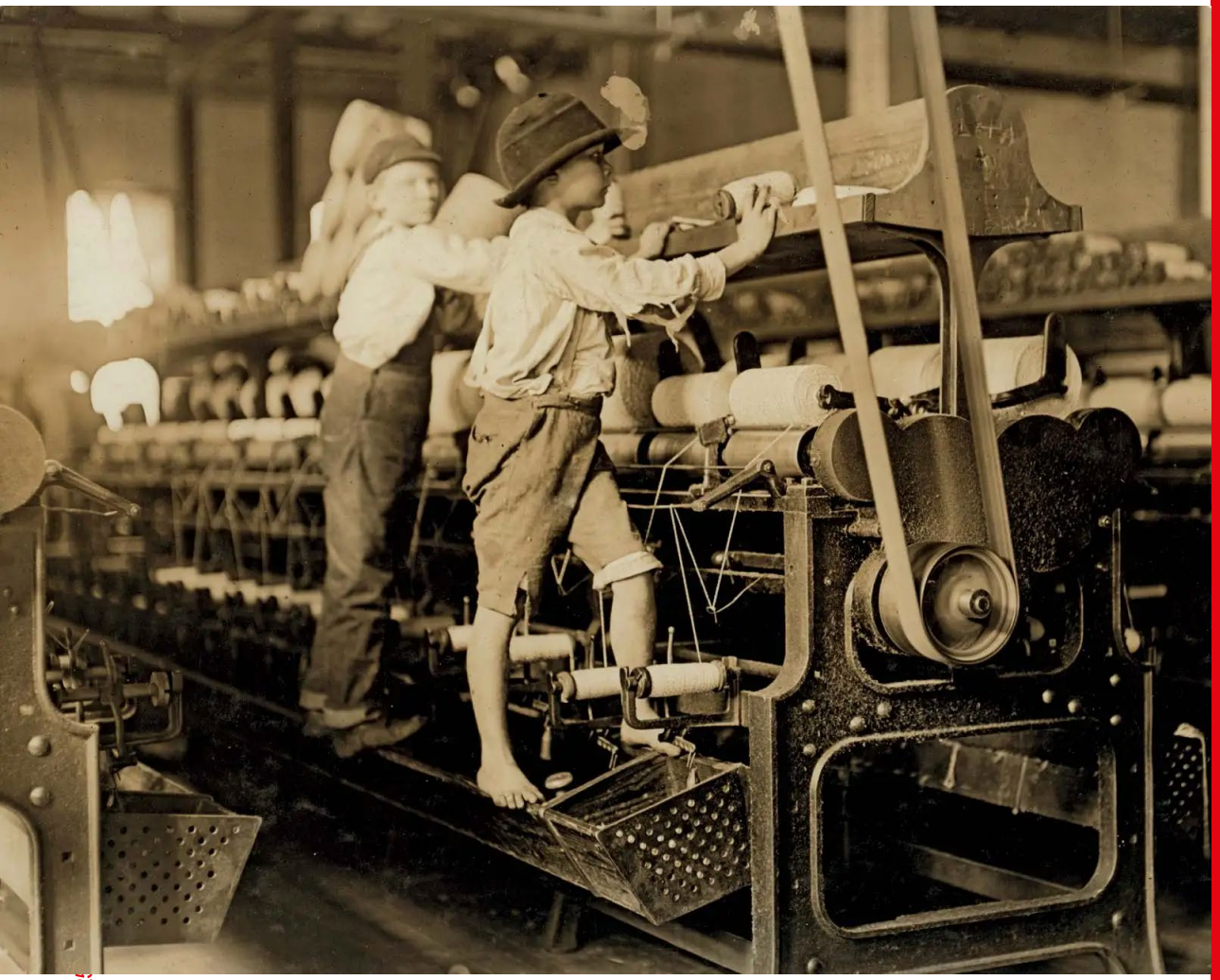
5 S: Methodology (5) - analogy with PDCA



Source: https://www.elsaber21.com/modelo-de-implementacion-de-las-5s-gestion-para-la-mejora-continua

The 5S cycle follows the PDCA (Plan-Do-Check-Act) principle.

- Major cleaning establishes the current state and sets objectives (Plan).
- Actions are carried out (Do) and results are verified (Check).
- The gap between observations and objectives is evaluated (Re-action).
- New actions are planned (Plan), and the cycle repeats.

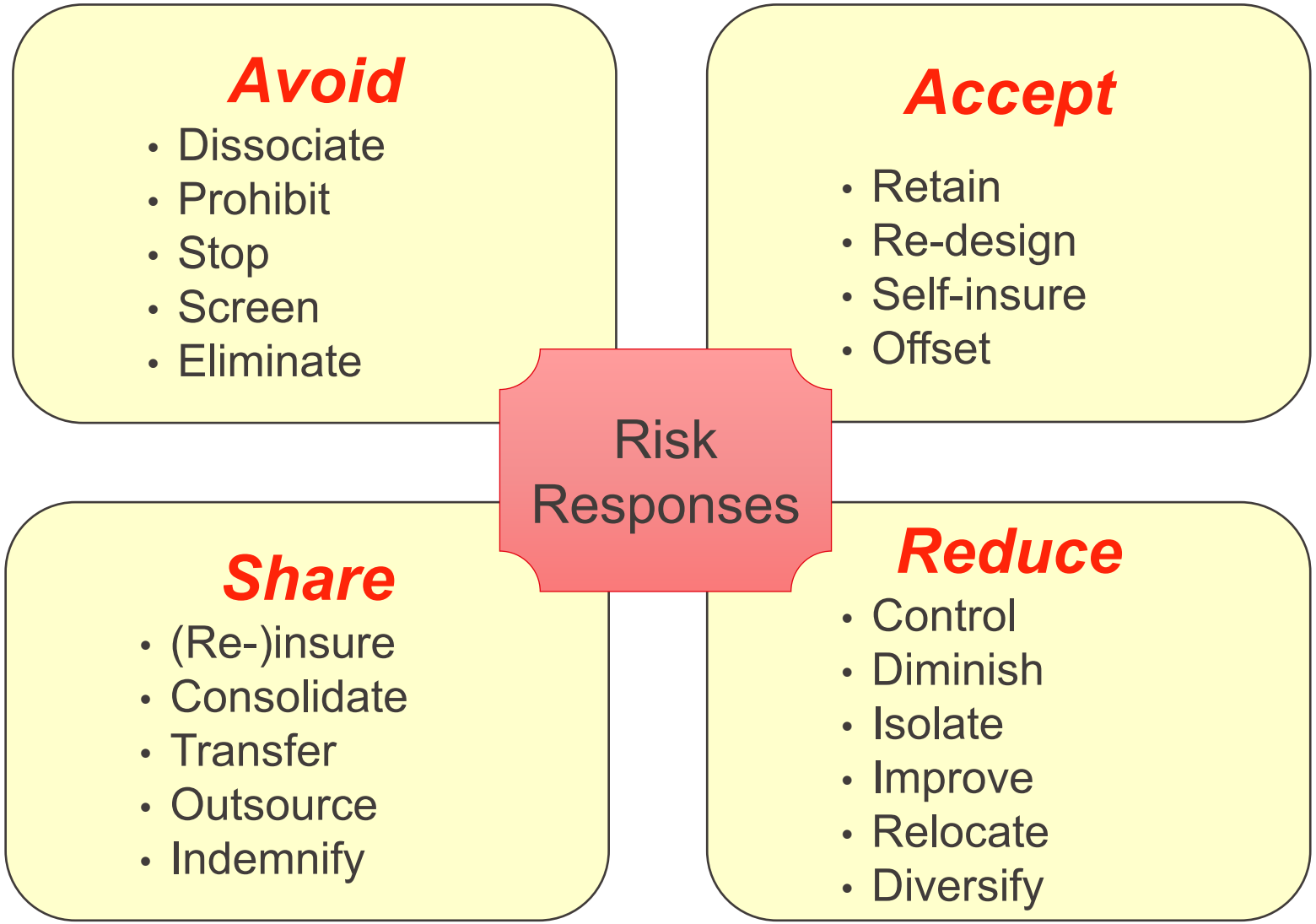


Source: https://www.britannica.com/story/the-rise-of-the-machines-pros-and-cons-of-the-industrial-revolution

Module 3.4

Conclusion

Conclusions: Risks response



Thierry Meyer

Conclusions: How mitigate a natural disaster ?

Tornado in Tuscaloosa, Alabama on April 27, 2011, second-deadliest day from twister in U.S. History (343 deaths)

Time 35``

Thierry Meyer