



Water Quality Control based on HACCP methodology and principles

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Why doesn't more companies implement water recycling?

- Due to insufficient mapping and handling the potential risks!
- Tools and competences needed:
 - In depth understanding of the actual production
 - In depth understanding of the potential risks
 - Concepts and tools to handle identified risk factors
- HACCP* is such a concept,
- but it needs adaptation to the issues of water recycling – including use of alternative water sources or integrated water treatment systems...

* Hazard Analysis and Critical Control Points

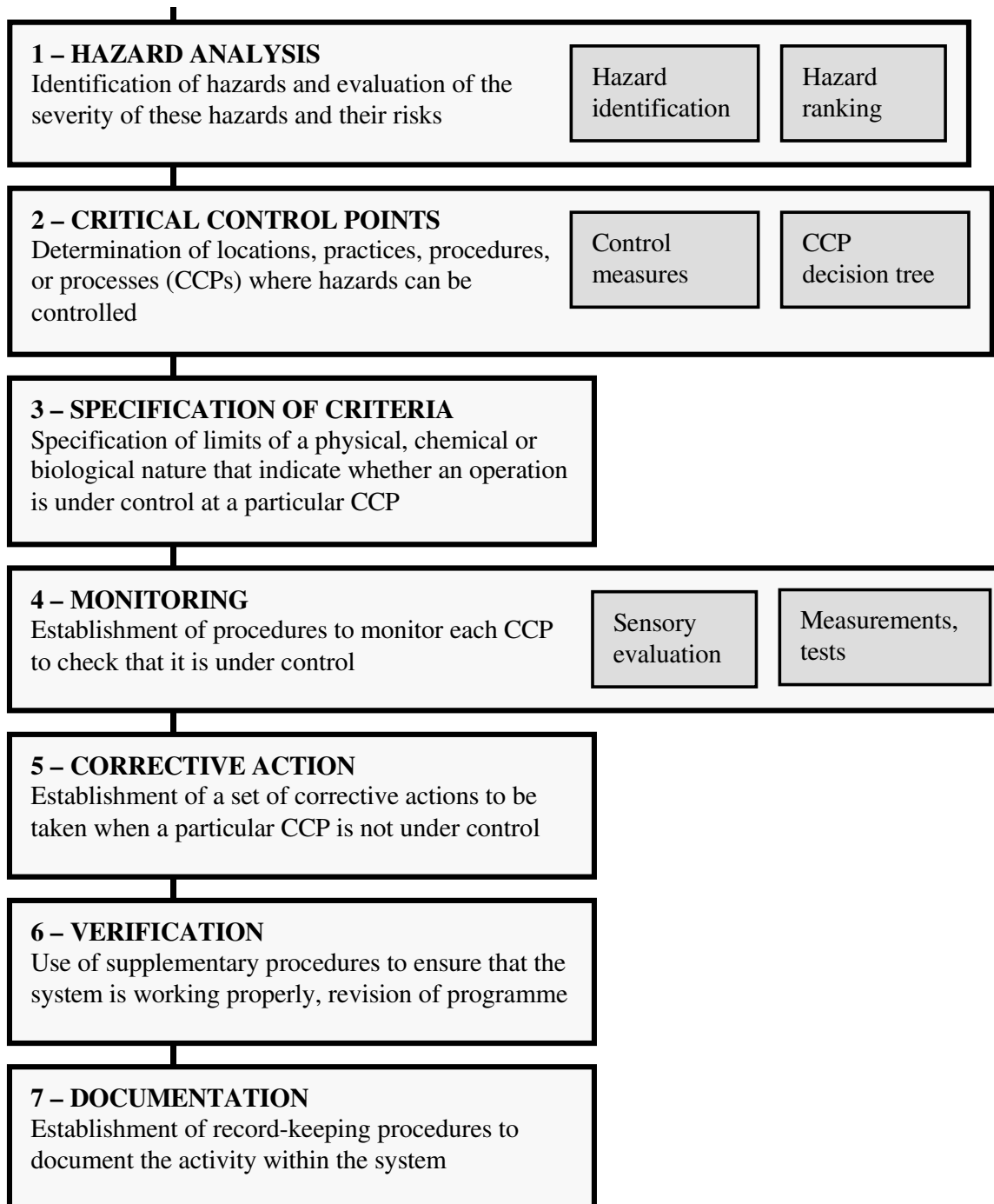
What is a Critical Control Point?

- **Critical Control Point (CCP)** is a point, step or procedure at which controls can be applied and a (food) safety hazard can be prevented, eliminated or reduced to acceptable (critical) levels.*

* FDA, US

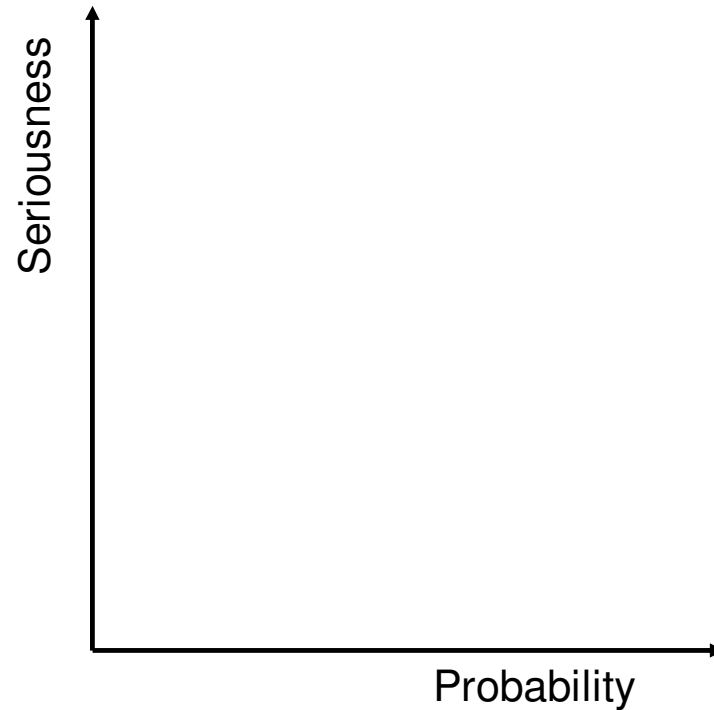
How to work with HACCP?

- **The seven steps...**



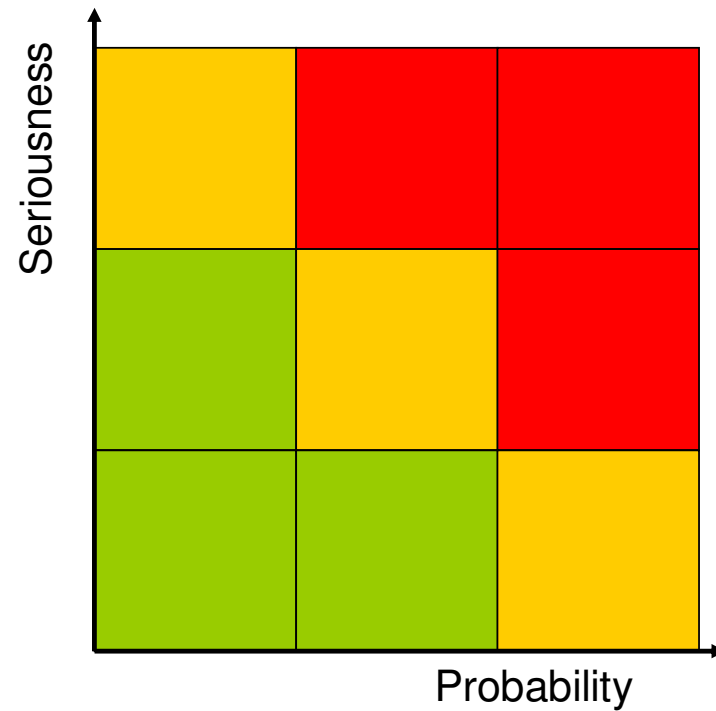
Hazard impacts and probability

- Two factors determines the situation:



Hazard impacts and probability

- Two factors determines the situation:



Seriousness...

- Here we might use the distinction from toxicity evaluation:
 - Acute effects
 - Long term effects
- Because this will impact the needed type of surveillance:
 - Acute effects => Intensive control/surveillance
 - Long term effects => Statistical surveillance or 'Monitoring'

What are the potential risks in water recycling?

Acute failures related to water recycling

- **Unforeseen variations** in the water source process – perhaps related to process problems in the process supplying the water
- **Contamination** of the water source related to leakages in chemical dosing systems leakages in pump sealings etc.
- **Insufficient treatment/cleaning** of the source water – perhaps related to failures in the treatment system e.g. breakthroughs in filters
- **Unforeseen impacts of water storage and transportation** – e.g. microbial growth in the system

What are the potential risks in water recycling?

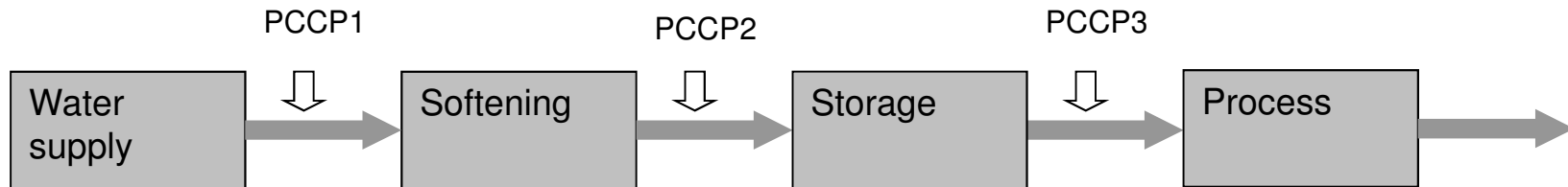
Long term impacts related to water recycling

- **Accumulation of compounds** with negative impacts in the system

How can we identify such risk factors?

- Taking the WQD as the starting point it must be determined **where in the supply of the individual water uses (sinks) the actual components are potentially impacted.**
- Hence the approach should be, for each identified component (and the related limit value) move backwards in the water network and identify the point where this water aspect is controlled / impacted - the Potential Critical Control Points (PCCP).
- **All processes impacting the water composition in an unforeseen way are in principles PCCPs**

An example:



Components / Parameters	Unit	PCCP1	PCCP2	PCCP3
Point of control		Water supply	Softening of the water	Hygienic properties of the water
Conductivity	μS/cm		< 500	
Hardness	ppm CaCO ₃		< 100	
Colour	ppm	< 30		
COD	ppm	< 50		
Cadmium	ppb	< 1		
Chromium	ppb	< 0,5		
Bacteria	CFU/100 ml			< 100
Legionella	CFU/100 ml			ND

Potential Critical Control Points

- might include:

- The supplying process – the ‘source’
- An integrated water treatment process
- The handling or storage of the water
- The use of water in production process steps
- Any other risk of contamination / pollution of the water supply for the actual process

How to rank the hazards?

For the seriousness it might be relevant to distinguish between:

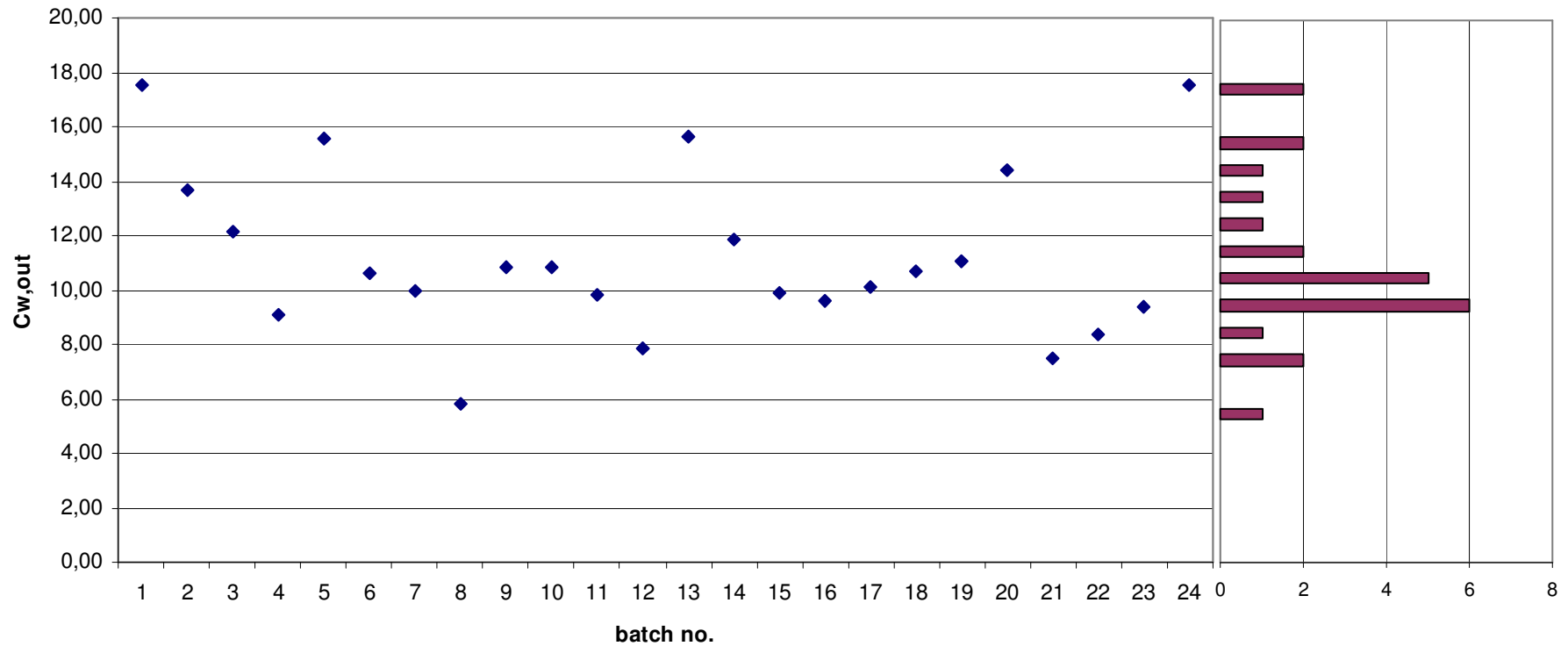
- **Potential acute effects on humans** – inducing illness or long term impacts due to infections or toxic chemicals – *which should lead to a high safety margin*
- **Potential acute economic impacts due to poor product quality** giving impacts in the market of the product – *which again should give a reasonable high safety margin*
- **Potential acute economic impacts due to malfunction of the actual production process** and hence loss of productivity and/or loss of intermediate products – *which might give more limited consequences and hence lesser safety margin*
- **Potential long term effects on equipment** – *which of course must be considered but perhaps not in the form of a safety margin...*

How to set reasonable safety margins?

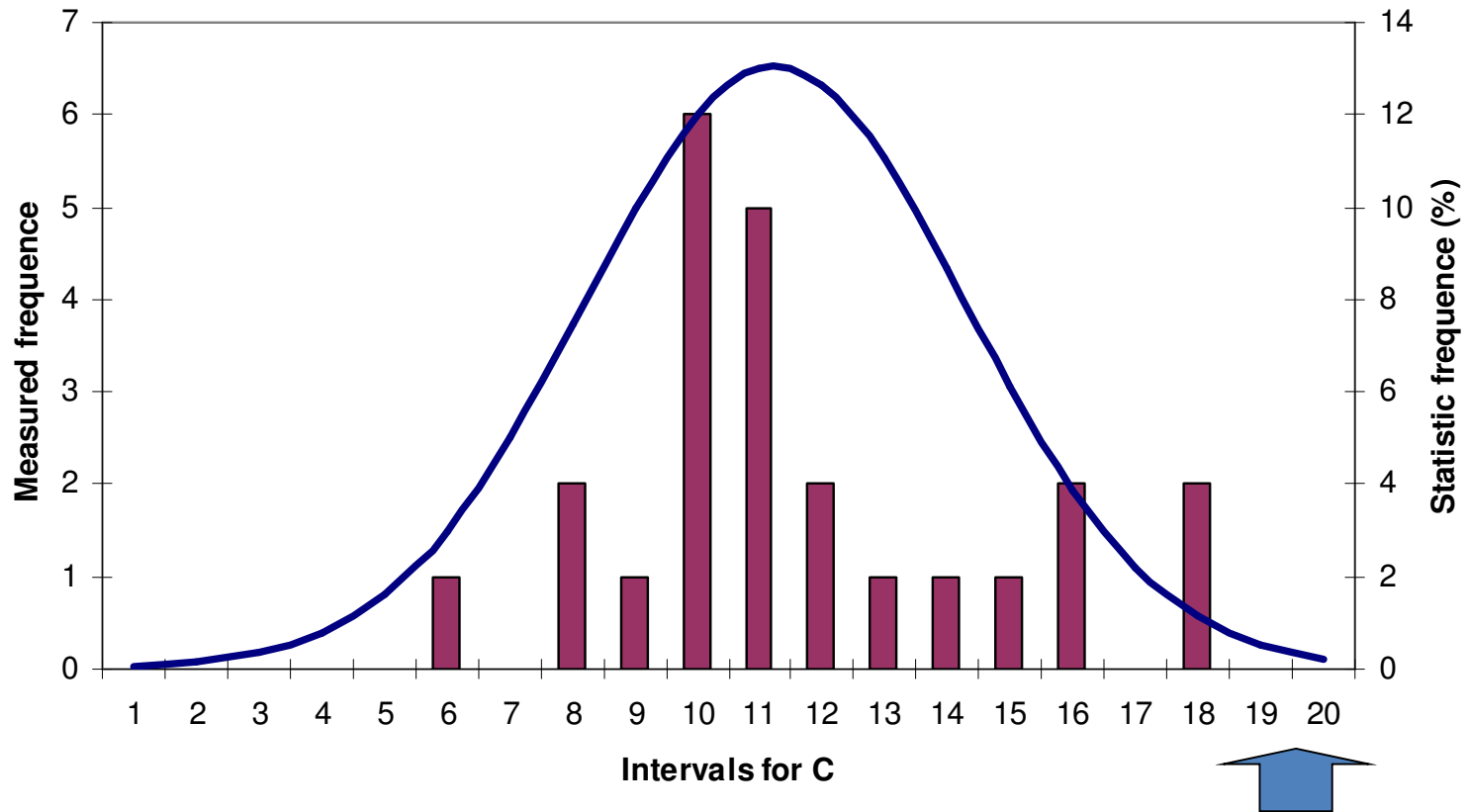
	Seriousness of potential hazards <i>Type of effect</i>	Safety margin Recommended surveillance
Product safety	High - due to the potential impacts on humans <i>Acute effects</i>	Safety margin: log 3 Intensive surveillance
Product quality	Medium - due to the potential economic impacts of bad product quality <i>Acute effects</i>	Safety margin: log 2 Intensive surveillance
Process water function	Medium - due to the potential malfunction of the process <i>Acute effects</i>	Safety margin: log 2 Statistical surveillance
Equipment, machinery and pipes	Low – due to possibility to correct <i>Long term effects</i>	Safety margin: log 1 Statistical surveillance
Health and working conditions	High - due to the potential impacts on humans <i>Acute effects</i>	Safety margin: log 3 Intensive surveillance

Remember to consider variations...

Below an example of a mapping
for a certain component:

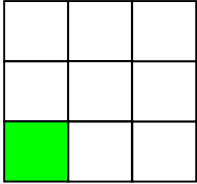
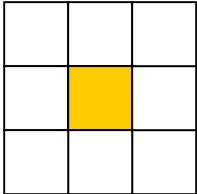
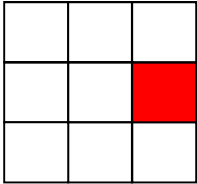


Determine variations...



Level to be used
in the match...?

Create a structure:

Process	Risk factors	Source	Controlling options	Risk assessment	CCP?
Process 1 receiving water from water supply system	Components / parameters of concern: Colour COD Cadmium Chromium - see limit values in table	Components controlled at: PCCP1 – the supply of fresh water	It is not possible for the company to impact / control the composition of the water supply. They can only monitor...		CP
Process 2 water softening	Components / parameters of concern: Conductivity Hardness - see limit values in table	Components controlled at: PCCP2 – the water leaving the softening unit	Regular regeneration Control for function of the resins		CP CCP 1
Process 3 water storage	Components / parameters of concern: 'Bacteria' (total counts) Legionella - see limit values in table	Components controlled at: PCCP3 – the outlet from the storage tank for softened water	Regular emptying of the tank Control for Legionella		CP CCP2

Determine the control routines

- and build it into the (certified?) management system

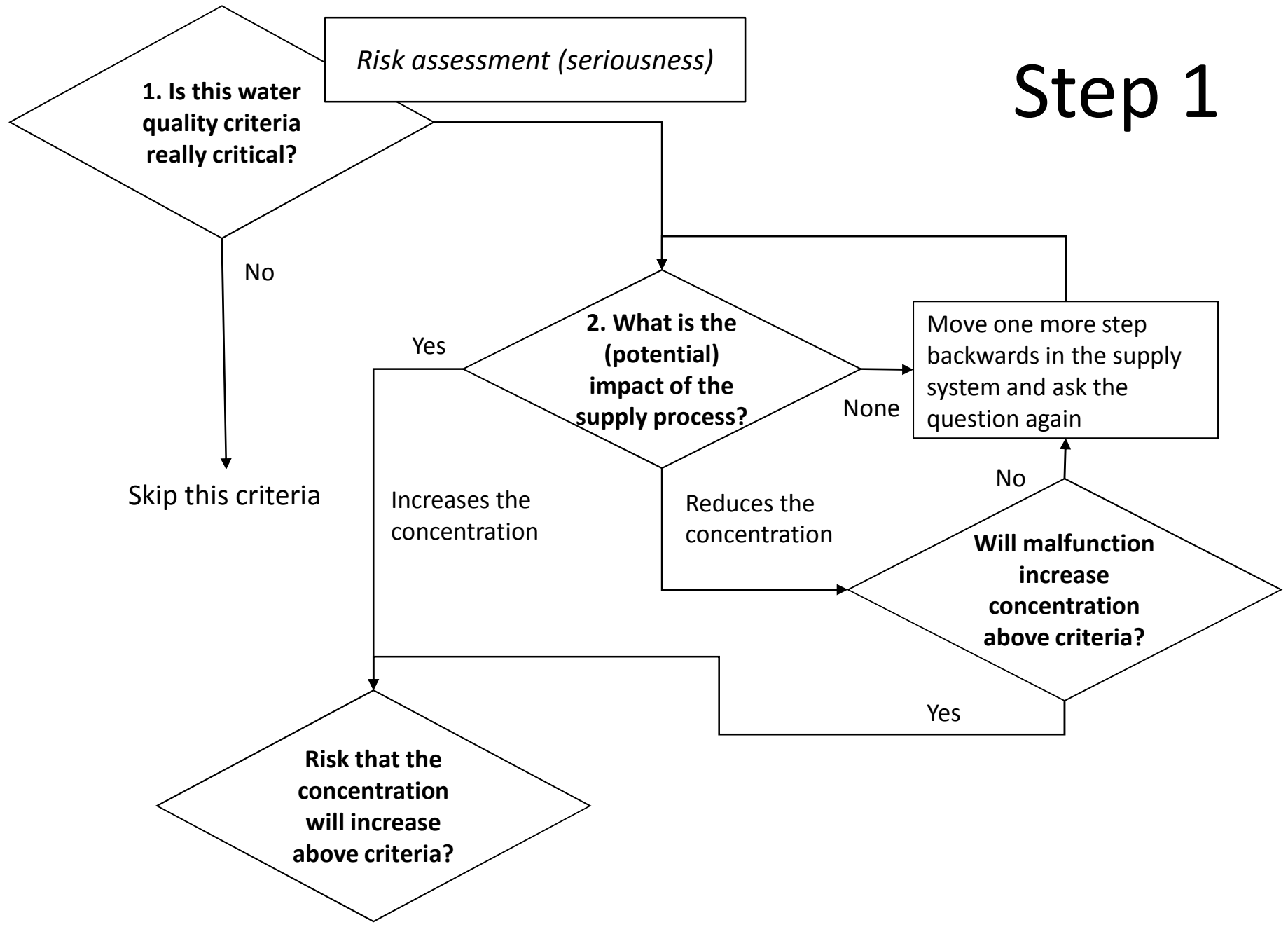
CCP no	Risk factors	Source	Controlling options	Critical limits	Surveillance			Corrective measures	
					Procedure	Frequency	Responsibility	Procedure	Responsibility
1	Components / parameters of concern: Hardness of the water	Components controlled at: The water leaving the softening unit	Control for function of the resins	Hardness < 100 ppm CaCO ₃	Sampling and analysis	Every morning	Technician xx	Replacement of ionic exchange resins	Technical department
2	Components / parameters of concern: Legionella	Components controlled at: The outlet from the storage tank for softened water	Control for Legionella	Not detected	Sampling and analysis	Friday afternoon before emptying the tank	Technician xx	Cleaning of the tank with disinfectant	Technical department

Can we computerise this work?

Yes, to some extent:

- We can prepare **supportive systems** that models the systems and handles the many factors
- We can make sure that the **variations and safety margins are clearly identified** when we define 'water quality criteria' and match with the new supplies
- We can prepare **list of the typical failures/risks** associated with the alternative supplies and the options for integrated treatment
- We can prepare list of **control devises** – on-line monitoring etc. – *bearing in mind that such control devises can also fail!*

Step 1



Risk assessment (seriousness)

1. Is this water quality criteria really critical?

No

Skip this criteria

Yes

2. What is the (potential) impact of the supply process?

None

Move one more step backwards in the supply system and ask the question again

Increases the concentration

Reduces the concentration

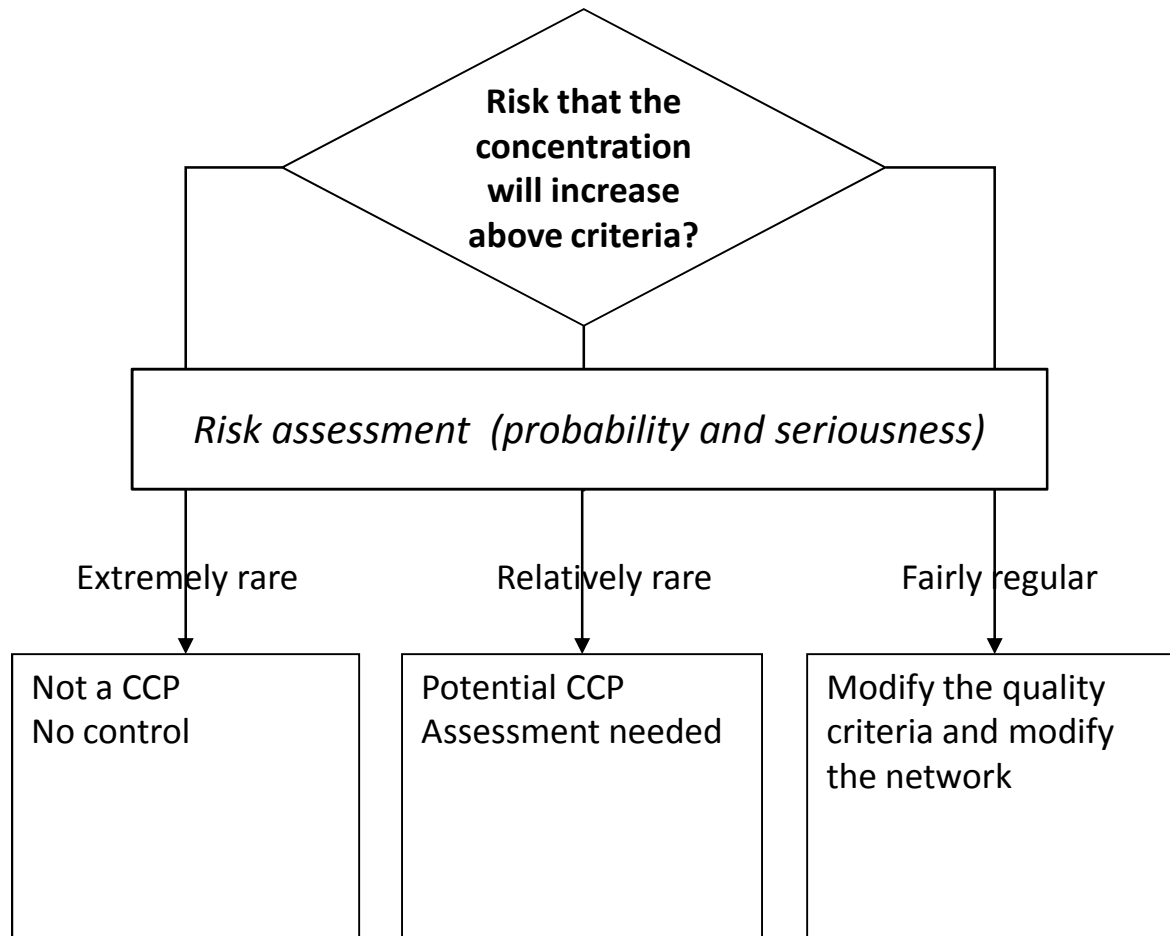
No

Will malfunction increase concentration above criteria?

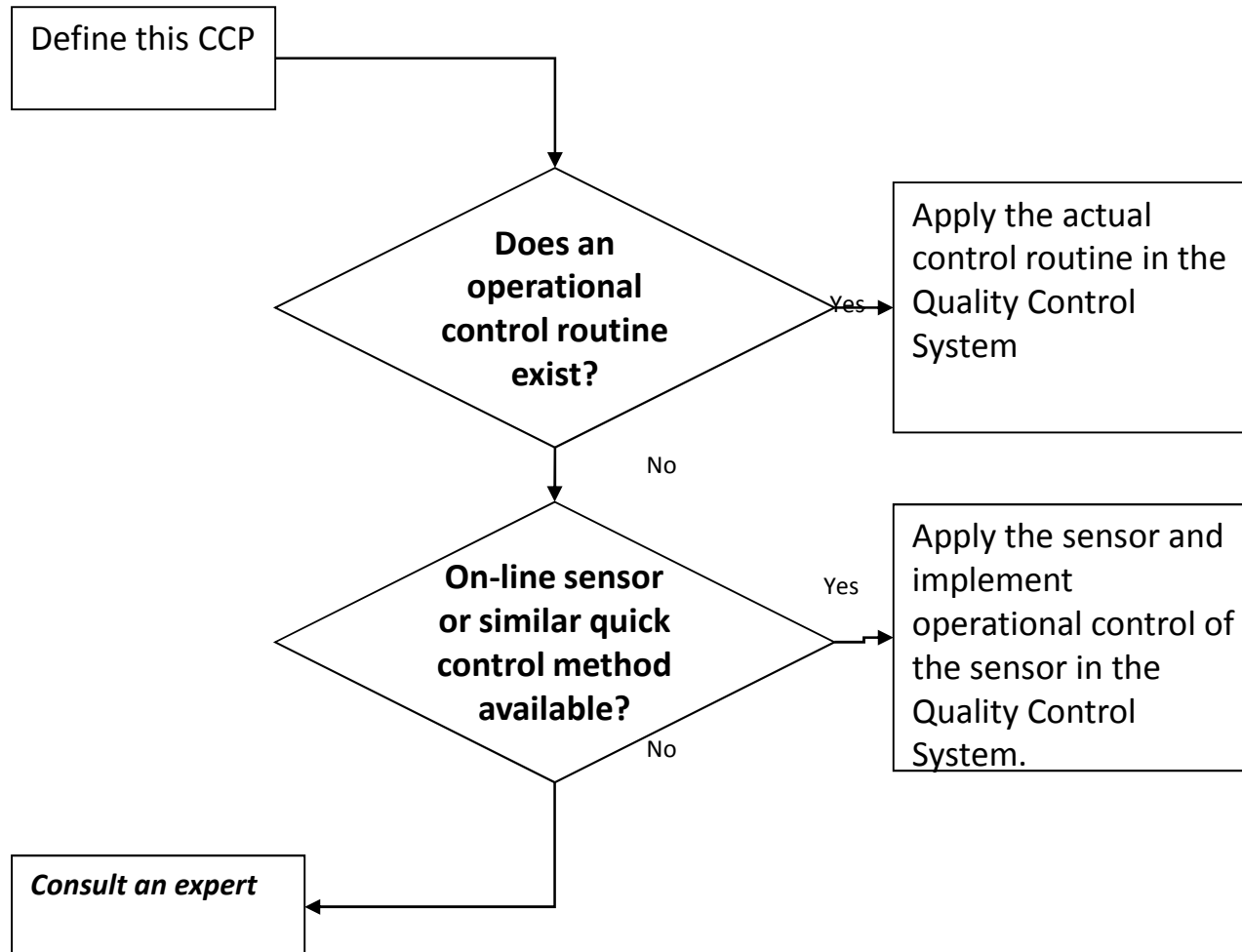
Yes

Risk that the concentration will increase above criteria?

Step 2



Step 3



That's all

- THANK YOU FOR THE ATTENTION