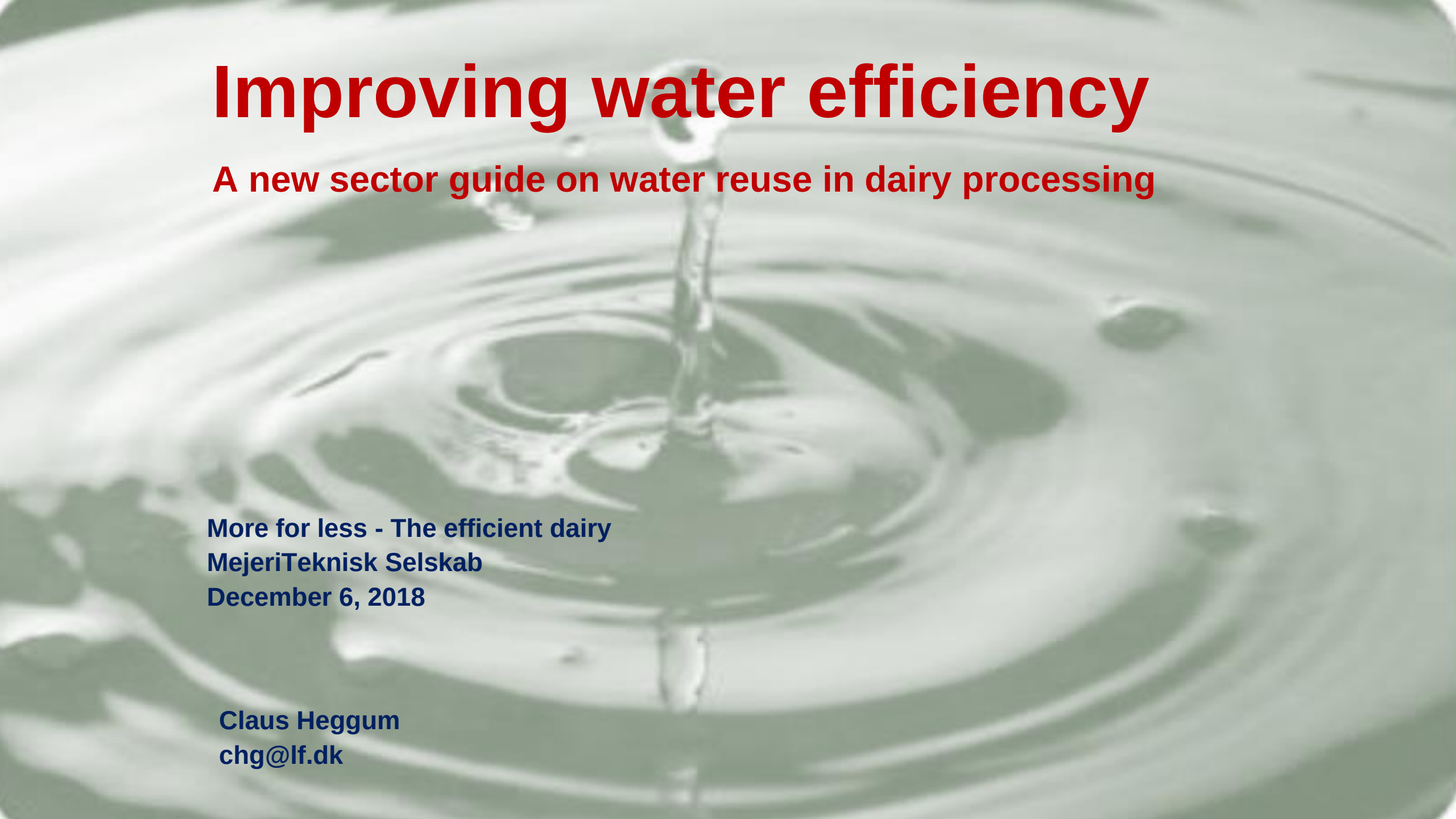

Improving water efficiency

A new sector guide on water reuse in dairy processing

More for less - The efficient dairy
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December 6, 2018

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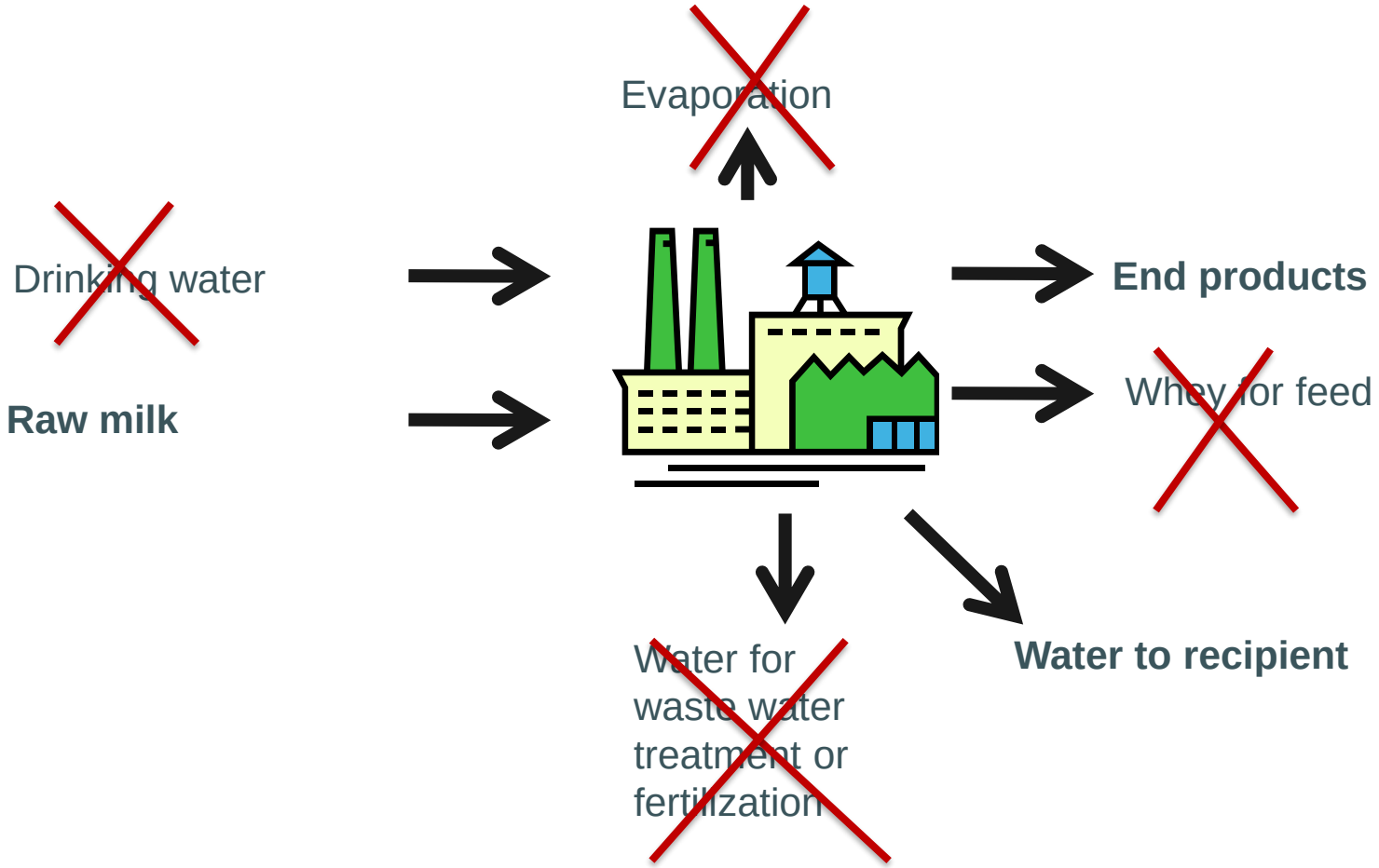
Fate of water

- **Milk water potentially available ~ external water needed**
- **Main uses:**
  - CIP and manual cleaning: 33-60%
  - Operation: 14-30%
  - Utility water: 9-29%
  - Seal water: 6-15%

Output of water	Thise	Sædager	Them
Fresh products	25%		
Cheese	½%	9%	2%
Evaporation	4%	4%	2%
Whey	3%	37%	55%
Waste water	66%	49%	49%
Other	2%	1%	1%

VISION:
ZERO-WATER- DAIRY PROCESSING



DRIVERS OF WATER REUSE

- **Reduced costs of external water supply**
- **Reduced costs of waste water**
- **Reduced transport costs**
- **Sustainability image**
  (70% of drinking water is used in food production)

CHALLENGES

- **Legal issues & requirements**
- **Burden of evidence on safety & suitability**

LEGAL ISSUES

- Reference to potable/ drinking water in food laws
- Definitions of water do not cover milk water
- Milk water & organic foods
- Milk water & animal by-products (ABP)

NEW INITIATIVES IN REGULATORY REFERENCES

EU:

EP proposal to amend of the COM proposal for a revised EU Drinking Water Directive:
"*Drinking water requirements* ***does not apply*** *……..*
where a food business ***can demonstrate*** *to the satisfaction of the competent national authorities* ***that the quality*** *of the water it uses* ***does not affect the hygiene of the products*** *or substances resulting from its activities and that such products or substances comply with Regulation (EC) No 852/2004 ……..."*

Global:

Revision of the Codex General Principles for Food Hygiene:
The FBO shall have an adequate supply of ***water-fit-for-purpose*** *with appropriately maintained facilities for storage, distribution and temperature control, should be available.*

APPROACH TO WATERS IN DAIRY PLANTS

Milk water is a milk product (i.e. a food)

→ Drinking water requirements not applicable

→ Can be reused/recicled and/or be purified again

→ No separate piping and storage equipment

Drinking water is water

→ Once used and suitable for reuse it becomes ”potable water”

→ Can be recycled or reclaimed again if relevant DW criteria are maintained

→ Separate piping and storage equipment

REDUCING THE BURDEN OF EVIDENCE

3 research and development 3 research and development

- Private-public partnership
- Multidisciplinary collaboration between industry (dairy, equipment), universities and competent authorities.
- Partly publicly financed

Dairy Sector Guide:
Code of Best Practices on (re)claiming and re(use) of waters in dairy processing

LESSONS LEARNED SO FAR?

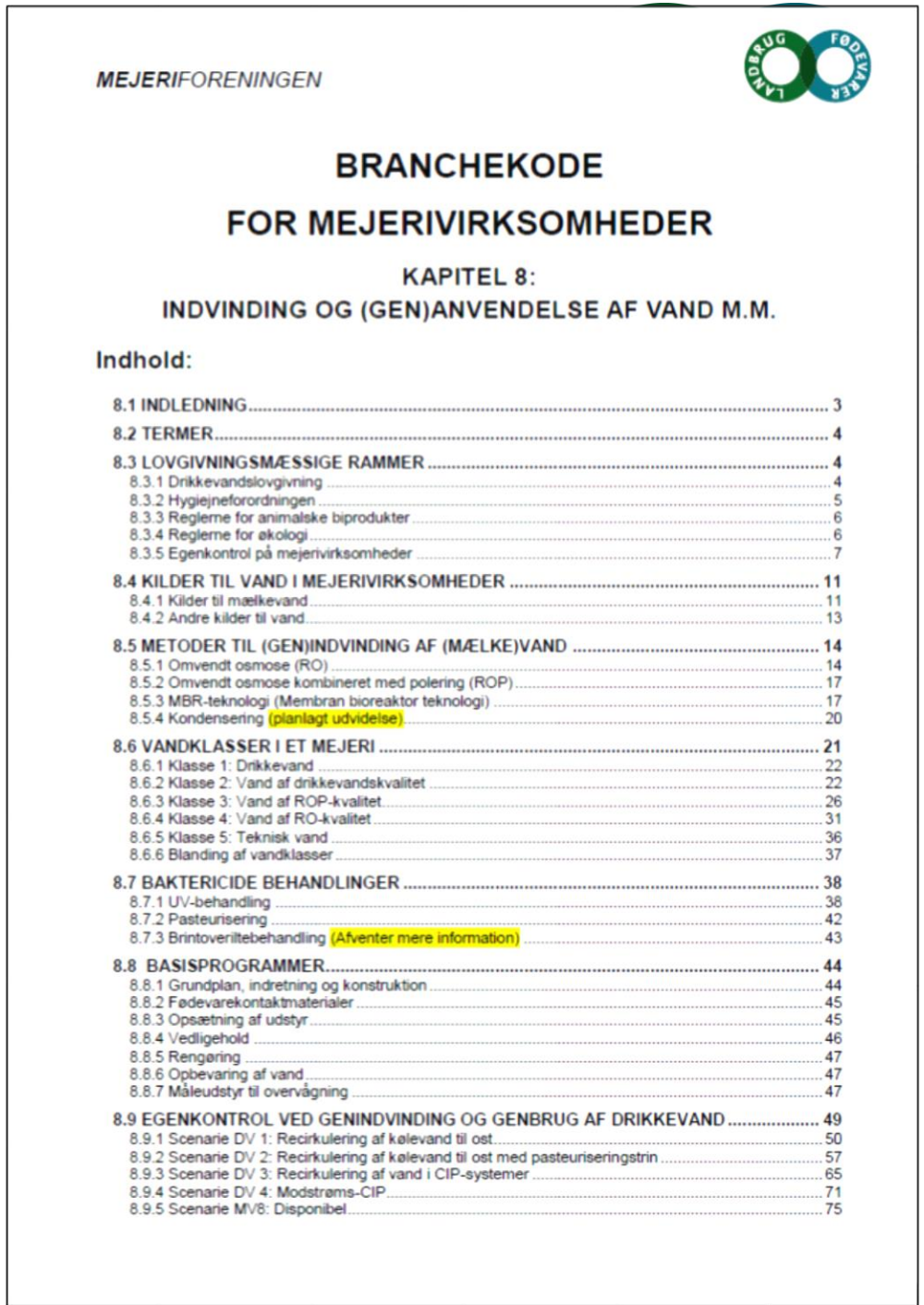
- **30-50 % of the water consumption is dedicated to cleaning.**
- **85-90% of the milk is water**
- **93-95% of whey is water**

⇒ Important source of water

- **The potential to save water is great:**
  - Control of use ~15% savings (average) of the water consumption
  - Claiming of milk water: up to ~60% savings
  - Optimizing reclaiming of milk water: ??
- **The recovery processes (RO) deliver safe water (short term use)**
- **Additional RO (=ROP) deliver safe water for longer term use**
- **The shelf life of milk water can be extended by heating & UV**

The Dairy Sector Guide

- General principles
- Legal obligations
- Description of recommended technologies
- 12 scenarios for direct implementation with
  - Relevant PRPs
  - Hazard analysis
  - Validation approach
  - Hazard Control Plans
  - Verification plans
- Submission to Competent Authorities early 2019
- Implementation by end of 2019



*MEJERI*FORENINGEN

BRANCHEKODE

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KAPITEL 8:

INDVINDING OG (GEN)ANVENDELSE AF VAND M.M.

Indhold:

TECHNOLOGIES COVERED

(Re)Claiming

- **Reverse osmosis (RO)**
- **RO & Polishing (ROP)**
- **Membrane & BioReactor technology (MBR)**

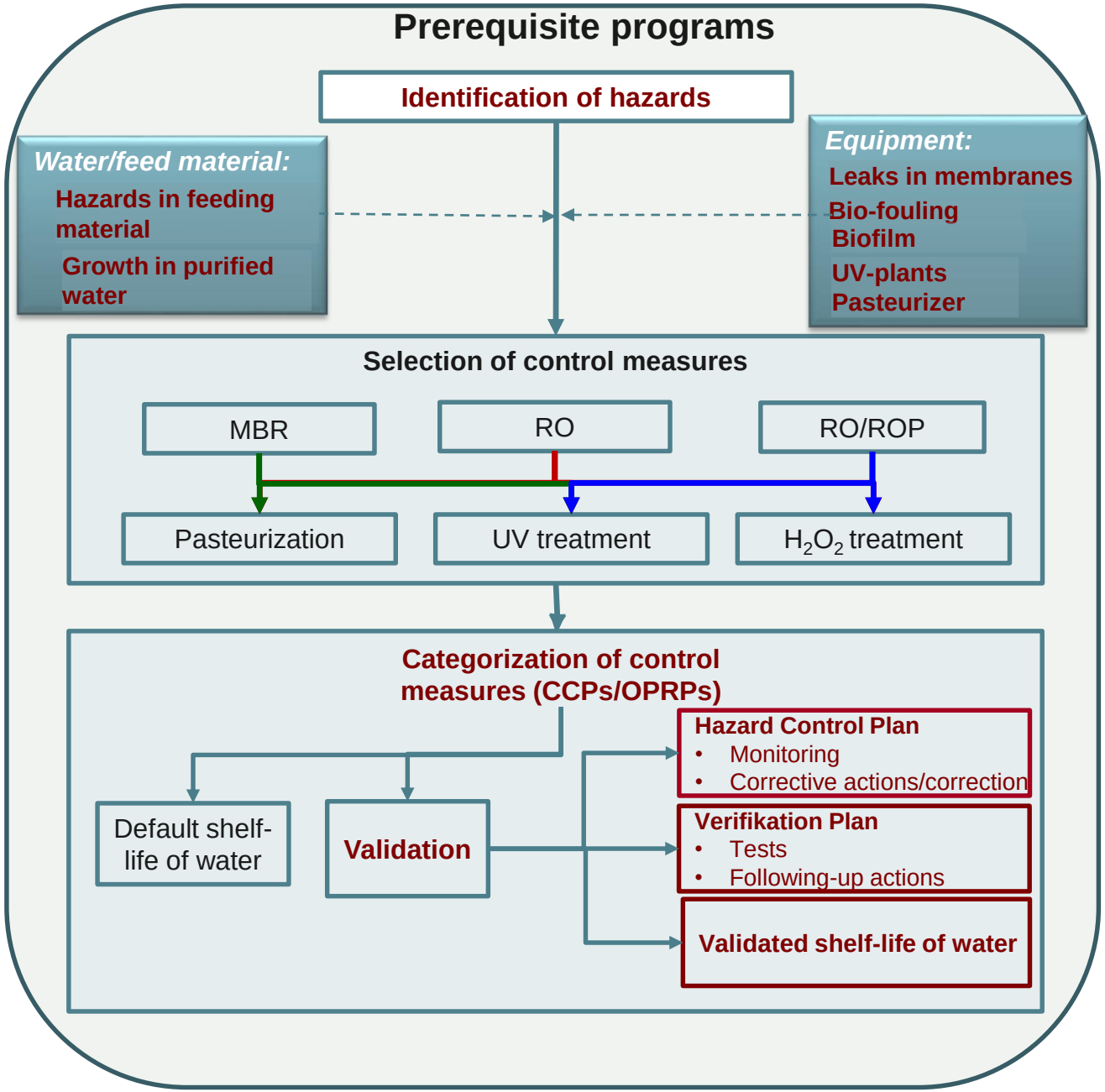
Microbiocidal treatments

- **Pasteurization**
  (≥ 72 °C, 15 s → >10 log reductions)
- **UV-Light treatment**
  (≥ 50 mJ/cm^2 → >4 log reductions)
- **[Chlorination]**
  (Technical water, only, due to risk of chlorates & other derivates)

5 WATER CLASSES

Class	Term	Sources	Quality
1	Drinking water	• External water supply	• All DW criteria met
2	Potable water	• Used drinking water • Used potable water • Other waters meeting quality criteria	• All food safety related DW criteria • Additional criteria acc. to history
3	Water of ROP quality (e.g. ROP water)	• RO water • Condensates • Used ROP water • Mix of all above sources	• Free of pathogens • Contains only urea (insignificant amounts of other nutrients) • Specific criteria according to intended use (e.g. corrosion)
4	Water of RO quality (e.g. RO water)	• Whey • Milk permeate (from UF of milk, white water etc.) • Whey permeat • Used RO water • Mix of all above sources	• Free of pathogens • Contains urea and small amounts of other nutrients • Specific criteria according to intended use (e.g. corrosion)
5	Technical water	• Purified dairy waste water • All above sources • Contaminated drinking water	• May contain nutrients • May contain pathogens • Specific criteria according to intended use (e.g. corrosion)

Dairy Sector Guide, Chapter 8



FOCUS OF HACCP-BASED CONTROL

TARGET OF CONTROLS	MEANS OF CONTROL
Minimize organic material Avoid fouling, wear and damage	• Monitoring conductivity, turbidity or COD • Monitoring of pressures
Avoid biofilm becoming a problem	• Operating time before cleaning (shelf life)
Prevent stagnant water	• Frequent visual check of piping & streams
Prevent microbial levels from exceeding unacceptable levels	• Microbiocidal treatment • Maximum shelf life (validated) • Controlled storage temperature
Document the UV treatment	
- Efficiency	• Minimum UV dose • Monitoring conductivity, turbidity or COD
- Safety	• Automatic flow diversion valve
Document the efficiency of heat treatment	• Temperature • Flow • FDV
Verify the overall operation	Chemical and microbial testing

14 SCENARIOS COVERED

Reuse/recycling of drinking water

- DV1: Recycling of water for cooling of cheese
- DV2: Recycling of water for cooling of cheese combined with pasteurization
- DV3: Recycling of water in CIP systems
- DV4: Counter-stream CIP

Reclaiming and use of milk water

- MV1: RO water with no microbiocidal treatment
- MV2: ROP water with no microbiocidal treatment
- MV3: RO water with UV treatment
- MV4: RO water with pasteurization
- MV5: ROP water with UV treatment
- MV6: MBR Recovery of RO water (
  - for technical use
  - for food use, when combined with UV treatment
- MV7: ROP water H_2O_2-treated

Reclaiming and use of water obtained from dairy waste water

- SV1: MBR water for technical use
- SV2: MBR water for food use

Quality of waters
Chemical criteria

	Water of potable quality	RO water	ROP water
COD		<100 mg O_2/L	<50 mg O_2/L
Conductivity[1] – food contact	<300 µS/cm	<200 µS/cm	<100 µS/cm
- other	<1000 µS/cm		
Turbidity - UV	<3 FNU	<3 FNU	< 1 FNU
- final rinse	<1 FNU	<5 FNU	
- other	<5 FNU		
Chloride - when stored	≤ 150 mg/L	≤ 150 mg/L	≤ 150 mg/L
- as ingredient	≤ 900 mg/L		

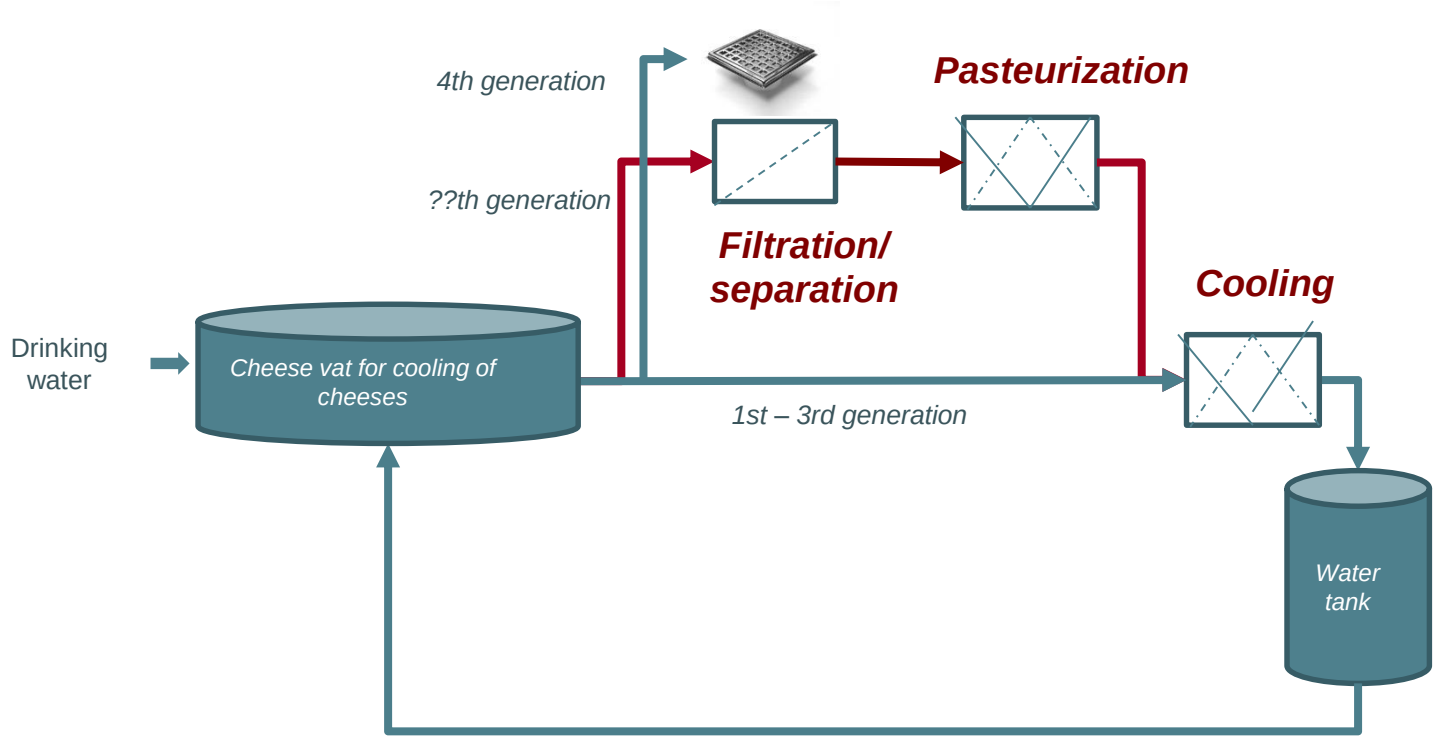
1) If used to separate CIP:
- Product rinse / clean water: 50 µS/cm
- Alkali / clean water: 40 µS/cm
- Acid / clean water: 30 µS/cm

Quality of waters
Microbiological criteria

	Water of potable quality	RO water	ROP water
Salmonella		Absent in 25 ml	
S. aureus		m=1; M=10	
L. monocytogenes		Absent in 25 ml	
Bacillus cereus		Absent in 1 ml	
Coliforms	Absent in 100 ml		
E. Coli (if coliforms detected)	Absent in 100 ml	Absent in 100 ml	
Total plate count 37 °C	m= 1; M= 20		
One of the hygiene indicators:			
• Total plate count 22 °C	m= 20; M= 200		m= 10; M= 100
• Psychrotrophic plate count (challenged)	m= 1000; M= 100		m= 100; M= 10
• Enterobactriaceae	m= 10; M= 100		m= 1; M= 10
• Pseudomonas spp.	m= absent in 100 ml; M= 100		

Example 1: SIMPEL RECYCLING SCENARIO

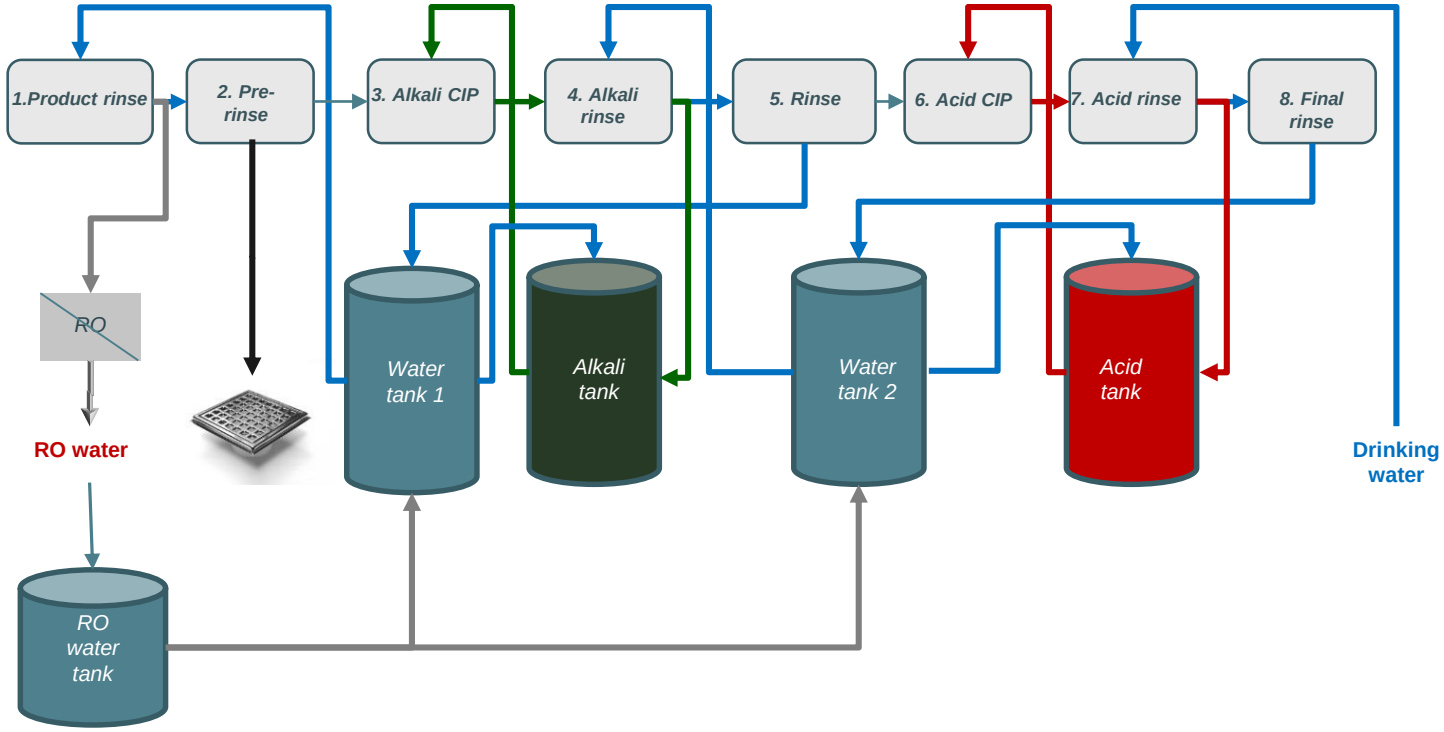
Recirculation of water for cooling cheese



Main issues	Monitoring (OPRPs):	Verification:
• Cross contamination between cheese vats • Biofilm	• Storage temperature • [Pasteurization] • Surface of cooled cheeses • No. of generations	• Coliforms/E. coli • A hygiene indicator • Listera spp. • Calibration

Example 2: SIMPLE RECYCLING SCENARIO

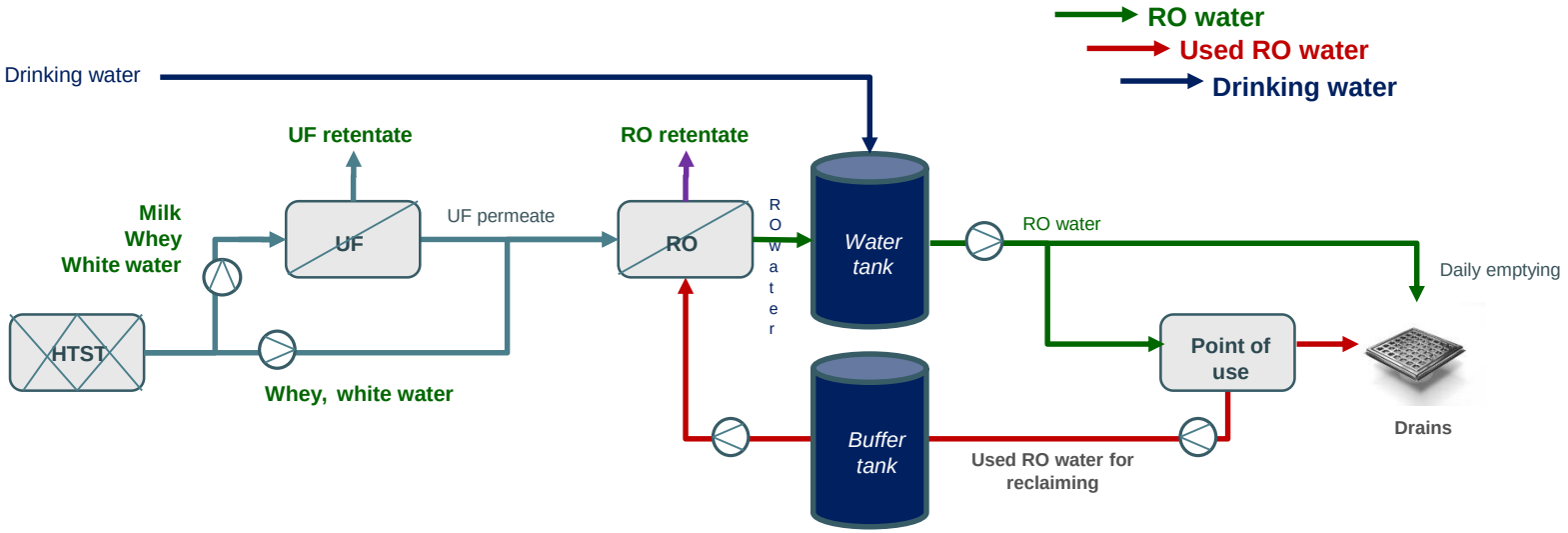
Counter-stream CIP



Main issues	Monitoring (OPRPs):	Verification:
• Impact of dilution of alkali/acid on cleaning efficiency • If RO water is used, built-up of nuttrients	• Conductivity (or pH) • Water consumption (acid & alkali tanks)	• Calibration

Example 3: MILK WATER SCENARIO

RO

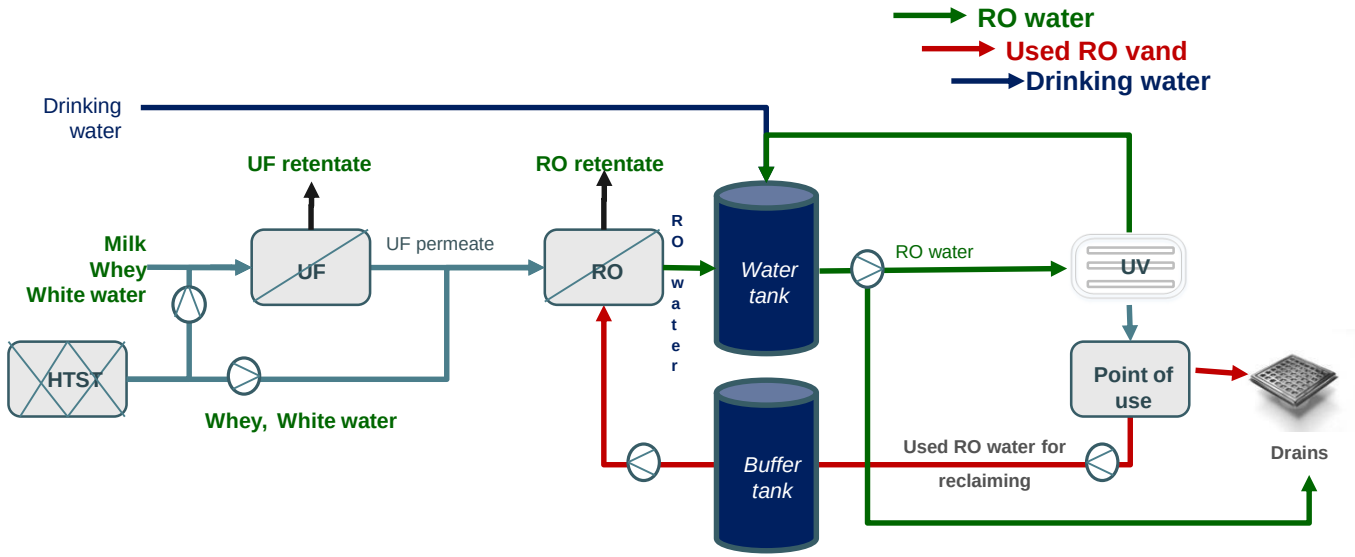


Main issues	Monitoring (OPRPs or CCPs):	Verification:

• Unpasteurized product
• Leaking membranes, valves ect.
• Stagneant water (”dead ends”)
• Biofilm
• Microbial growth potential
	• Pasteurizer, when used (time, tempertur, pressure, FDV)
	• RO-plant
	  • Flow
	  • Pressure (in/out or difference)
	  • Conductivity/Brix
	  • Luminosity
	• Operational time
		• COD, turbidity or conductivity
		• Coliforms/E. coli
		• Hygiene indicator chosen by validation
		• B. cereus
		• L. monocytogenes & Salmonella
		• Calibrations

Example 3: MILK WATER SCENARIO

RO with UV



Main issues	Monitoring (OPRPs or CCPs):	Verification:

In addition to RO:
• Effective operation of the UV-plant
• Broken glass/mercury
• Shelf life of water
	In addition to RO:
	• UV-plant
	  • Operational UV-dosage
	  • Flow
	  • False air
	  • FDV (turbidity, damage)
	• Operational time
		In addition to RO:
		• Function of FDV
		• Luminosity (tubidity, conductivity or COD)
		• Chloride
		• Coliforms/E.coli
		• Hygiene indicator chosen by validation
		• B. cereus
		• L. monocytogenes & Salmonella
		• Calibrations

DOCUMENTATION OF WATER SYSTEMS

	Initially drinking water			Initially milk water					Initially dairy waste water		
Class when used: / Documentation:	Drinking water	Potable water	Technical water	Water of potable quality	ROP water	RO water	MBR-RO water for food use	MBR-RO water for technical use	Water of potable quality	MBR water for food use	MBR water for technical use
Basic system documentation											
Documentation for compliance with criteria for drinking water		X		X					X		
Description of the system and any treatments		X	X	DSG	DSG	DSG	DSG	X	X	DSG	DSG
Hazard analysis				DSG	DSG	DSG	DSG		X	DSG	DSG
Operational documents											
Procedures/instructions on appropriate use		X	X	X	X	X	X	X	X	X	X
Hazard control plan				DSG	DSG	DSG	DSG		X	DSG	DSG
Verification Plan	X	X	X	DSG	DSG	DSG	DSG		X	DSG	DSG
Records											
Monitoring results				X	X	X	X		X	X	
Verifications results	X	X	X	X	X	X	X		X	X	X

DSG = Covered by the Dairy Sector Guide

DEFAULT SHELF-LIVES

Scenario / Storage	Ambient	Chilled/ warm
RO-water	1 day	
RO-water + UV (single treatment)	4 days	7 days
RO-water + UV (continous treatment)	14 days	21 days
RO-water + past.	7 days	14 days
ROP-water	2 days	
ROP-water + UV (single treatment)	7 days	12 days
ROP-water + UV (continous treatment)	21 days	28 days

VALIDATION PROTOCOL

Objectives:

- Determine the shelf-life (time between each emptying & cleaning of the system)
- Selection of the site-specific hygiene indicator

General approach (specified for each scenario):

1. Determine the validation period: >>the expected/default shelf-life
2. Operation until monitoring (operational parameters) shows stability
3. Frequent sampling and testing for:
   - Total plate counts 22 °C
   - Enterobacteriaceae
   - Psychrotrophic counts (challenged)
   - Pseudomonas

   untill one or more of the limits are exceeded
4. Then, check that the water meets all (remaining) quality criteria

Shelf-life to be based on the indicator that first exceeds the limit
The indicator that first exceeds the limit is chosen as the organism for hygiene verification

Summary

- **Great potential of optimize water resources in dairying**
  - Reuse/recykling in CIP (all productions)
  - Claiming of milk water (mostly powders/cheese)
- **Technology is well known to dairy staff**
- **It is safe, if operated correctly**

- **Legal framework is changing (Codex, EU, DK)**
- **Great support from DK Competent Authorities**
- **Still need of developing new data/fine-tuning existing scenarios:**
  - Research conducted by DTU & KU
  - Coordinating data collection within the sector
  - Better on-line monitoring methods (microbiology)


Thank you!