



LISTERIA CONTROL IN SEAFOOD PROCESSING ENVIRONMENTS: – A FIVE-POINT PLAN

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 Fagdag om Listeriakontroll, 13th November 2019, Gardermoen, Norway



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Listeriosis 2017

Table 2: Reported hospitalisation and case fatalities due to zoonoses in confirmed human cases in the EU, 2017

Disease	Number of confirmed ^(a)		Hospitalisation			Deaths			
	Human cases	Status available (%)	Number of reporting MS ^(b)	Reported hospitalised cases	Proportion hospitalised (%)	Outcome available (%)	Number of reporting MS ^(b)	Reported Deaths	Case Fatality (%)
Campylobacteriosis	246,158	27.6	17	20,810	30.5	72.8	16	45	0.04
Salmonellosis	91,662	43.1	14	16,796	42.5	67.8	17	156	0.25
Yersiniosis	6,823	27.1	14	616	33.4	65.5	15	3	0.07
STEC infections	6,073	41.0	18	933	37.5	66.1	21	20	0.50
Listeriosis	2,480	40.4	16	988	98.6	65.8	18	225	13.8
Q-fever	928	NA ^(c)	NA	NA	NA	56.0	10	7	1.35
Echinococcosis	827	31.2	14	140	54.3	30.1	14	1	0.40
Brucellosis	378	45.8	10	104	60.1	33.9	10	1	0.78
Tularaemia	321	38.3	9	76	61.8	51.1	9	1	0.6
West Nile fever ^(a)	212	72.2	8	134	87.6	98.6	9	25	12.0
Trichinellosis	168	44.6	9	56	74.7	40.5	9	0	0.0
Congenital toxoplasmosis	40	57.9	3	18	NA	63.2	3	0	0.0
Rabies	1	NA ^(c)	NA	NA	NA	0.0	0	NA	NA

(a): Exception: West Nile fever where total number of cases were included.
 (b): Not all countries observed cases for all diseases.
 (c): NA: Not applicable as the information is not collected for this disease.

The European Union summary report on trends and sources of zoonoses, zoonotic agents and food-borne outbreaks in 2017
 EFSA Journal 2018;16(12):5500



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Major food groups affected

	2017	2016	2015	2014	2013	Data source
RTE food						
RTE food – occurrence (%) by detection method (number of tested samples by detection method; number of reporting MS)^(a)						
Fish and fishery products	6.0% (n = 6,730; 22 MS)	5.1% (n = 2,918; 22 MS)	3.2% (n = 4,658; 22 MS)	5.8% (n = 3,436; 16 MS)	5.1% (n = 3,479; 20 MS)	EFSA
Meat and meat products (beef, pork, broiler and turkey meat)	1.8% (n = 22,544; 19 MS)	3.3% (n = 15,161; 23 MS)	2.8% (n = 16,789; 21 MS)	2.1% (n = 67,215; 18 MS)	3.4% (n = 44,977; 21 MS)	EFSA
Soft and semi-soft cheeses made from raw or low-heat-treated milk	0.9% (n = 6,117; 17 MS)	2.6% (n = 853; 15 MS)	1.4% (n = 730; 13 MS)	1.0% (n = 2,573; 13 MS)	4.2% (n = 2,542; 13 MS)	EFSA
Hard cheeses made from raw or low-heat-treated milk	0.1% (n = 5,039; 15 MS)	1.0% (n = 509; 9 MS)	1.3% (n = 858; 11 MS)	0.2% (n = 10,175; 9 MS)	0.7% (n = 1,609; 12 MS)	EFSA
Fruit and vegetables	0.6% (n = 1,773; 17 MS)	0.7% (n = 1,043; 16 MS)	2.1% (n = 1,456; 17 MS)	2.1% (n = 1,503; 17 MS)	2.1% (n = 1,991; 15 MS)	EFSA
Salads	4.2% (n = 902; 14 MS)	1.9% (n = 1,042; 14 MS)	1.9% (n = 1,238; 13 MS)	1.1% (n = 1,154; 15 MS)	2.4% (n = 1,822; 14 MS)	EFSA

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Listeria associated to seafood

Multi-country outbreak of Listeria monocytogenes linked to consumption of salmon products



Ready-to-eat salmon products, such as cold-smoked and marinated salmon, are the likely source of an outbreak of Listeria monocytogenes that has affected Denmark, Germany and France since 2015. EFSA and the European Centre for Disease Prevention and Control (ECDC) used whole genome sequencing to identify the multi-country outbreak.

By 8 October 2018, 12 cases including four deaths had been reported in the affected countries.

World Africa Asia Australia Europe Latin America Middle East US & Canada

'Smoked salmon' listeria kills two in Australia

© 24 July 2019

Italy recalls packs of smoked salmon over listeria scare

News by Owen Evans - 4 December 2018

Authorities recall packs of "Scottish Pride" smoked salmon.

Multi-country outbreak of Listeria monocytogenes linked to cold-smoked fish

Cold-smoked trout and salmon produced in Estonia is the source of the Listeria monocytogenes outbreak which has affected 22 people in five countries since 2014.

Experts from EFSA and the European Centre for Disease Prevention and Control (ECDC) were able to confirm the source of the infection using whole genome sequencing and traceability investigations.

The affected countries are: Denmark (9 cases), Estonia (6), Finland (2), France (1), and Sweden (4). Five people have died. The latest case was reported in Denmark in February 2019.

New cases cannot be ruled out until the exact point of contamination in the food processing plant has been identified.

SFA recalls Atlantic salmon from Norway after listeria monocytogenes was detected in sample



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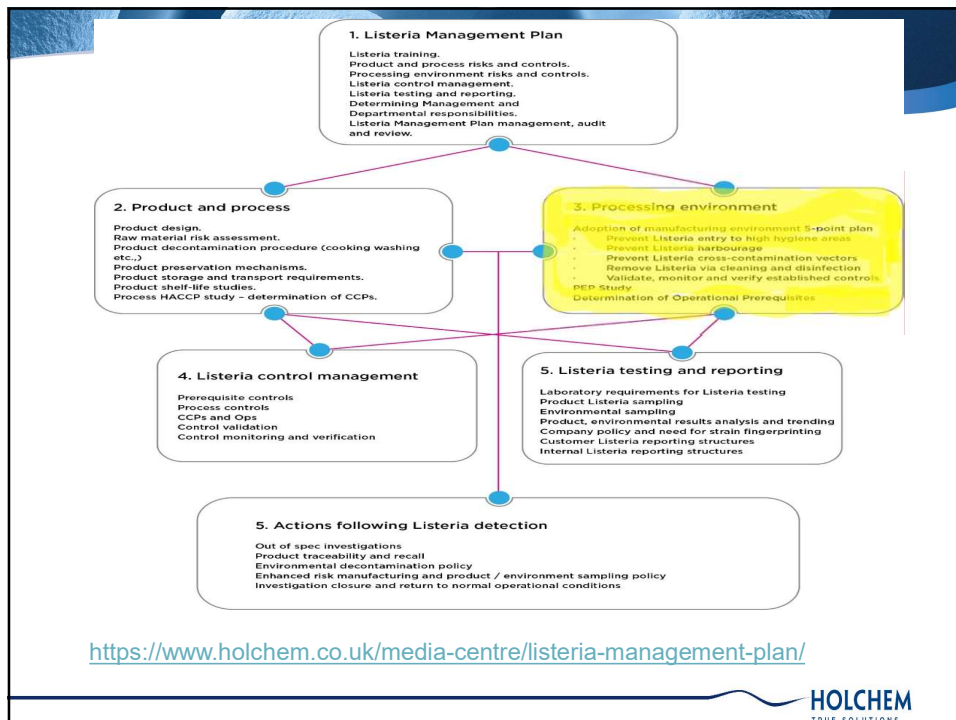
Listeria – the perfect storm

- Survives in the processing environment
- Grows in the processing environment
- Grows in the storage and distribution chain
- Grows particularly well in the human body






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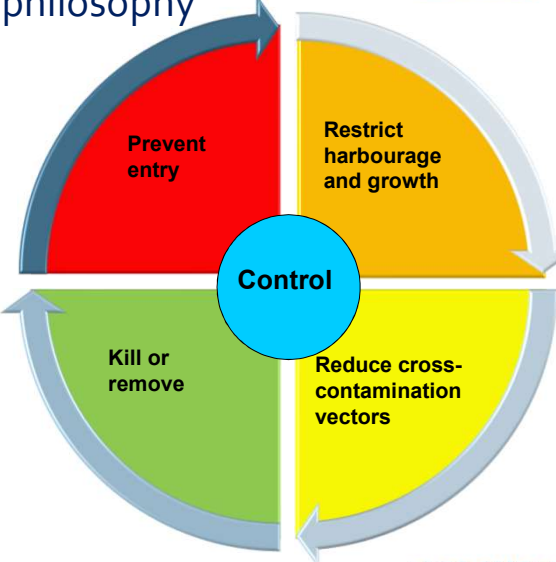


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Pathogen control philosophy

Salmonella and dry foods




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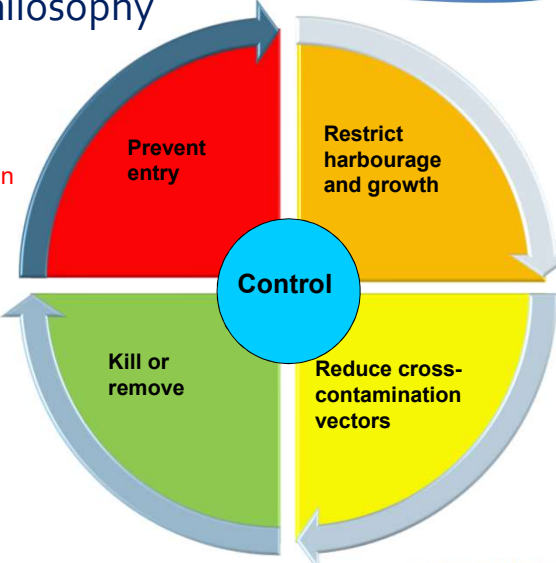
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Listeria control philosophy

1. Hygiene is never the cause
2. Hygiene is never the solution
3. Hygiene can prevent escalation

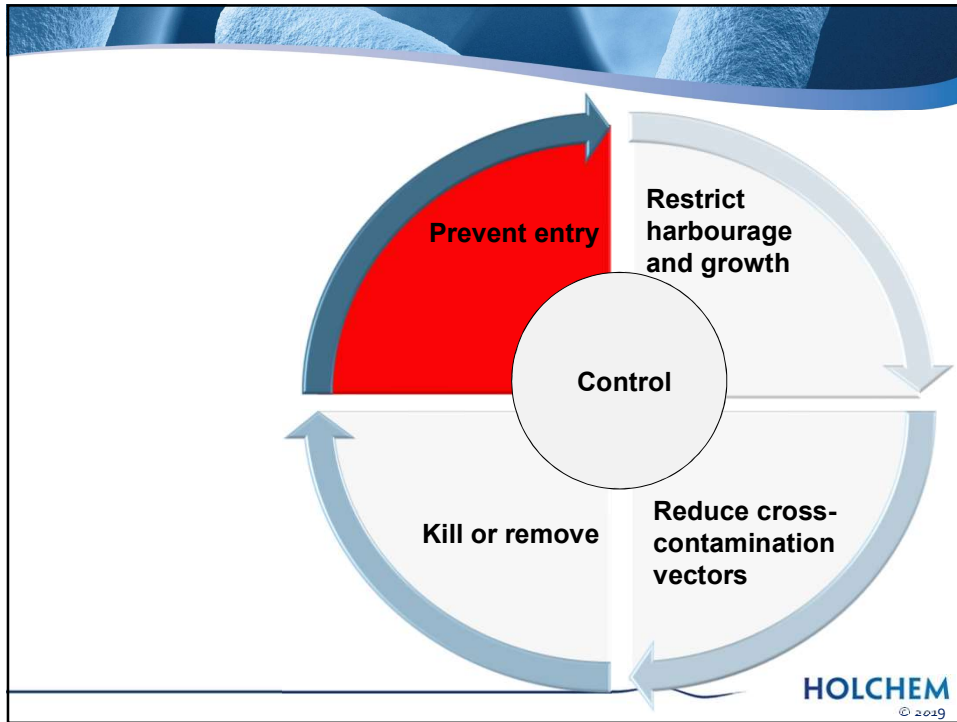
There is no silver bullet



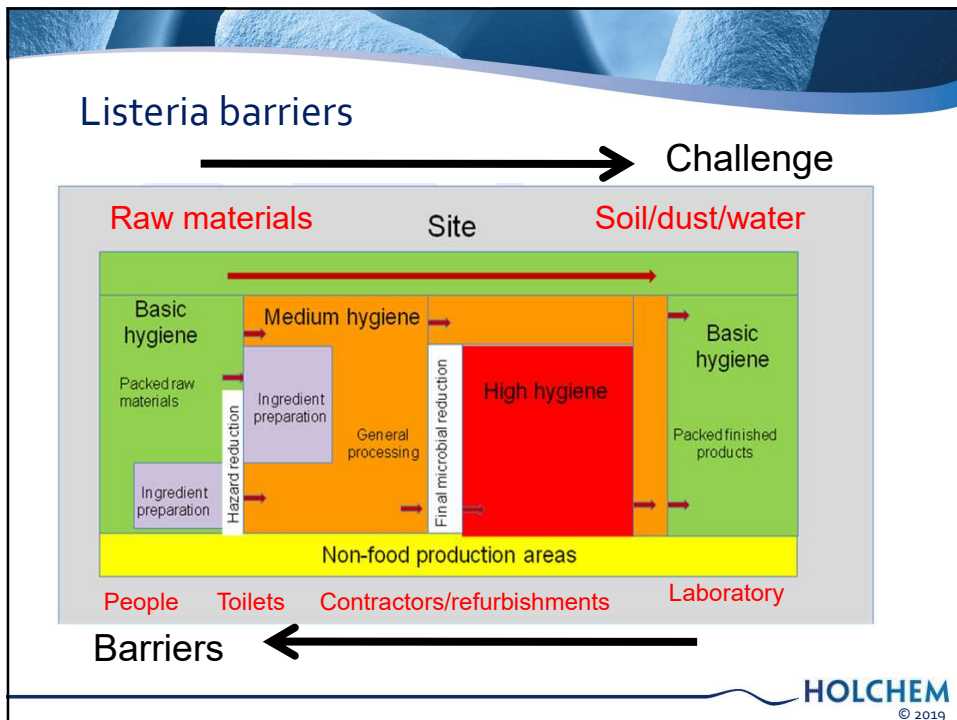


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Factory barrier

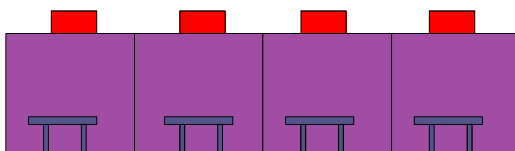
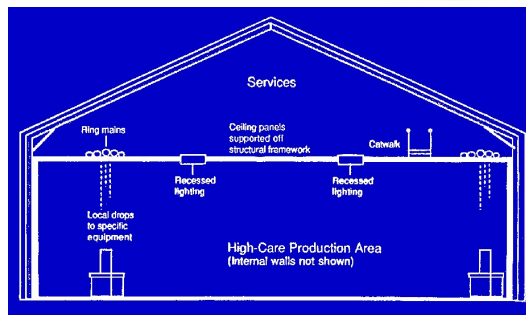


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A box within a box

- External services
- Product, packaging, equipment, personnel only
- Small as possible
- Fewest, controlled entrances



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Wall-to-floor junctions?

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Pressure differentials and floor cavities

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Drain design

Disseminate or collect?

A

- No edge in-fill
- Metal to metal contact / crevices
- Sharp inside corners
- Fixed water trap
- Not drainable body

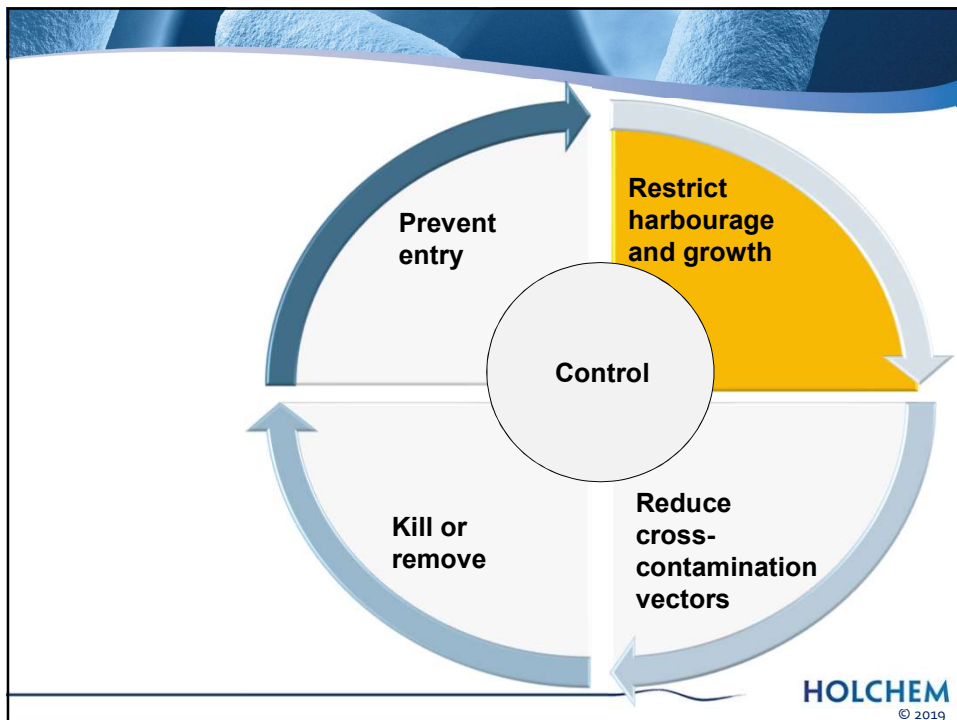
B

- Edge in-fill
- Radiused inside corners
- Weldings without crevices
- Removable water trap
- Drainable body

EHEDG Building design

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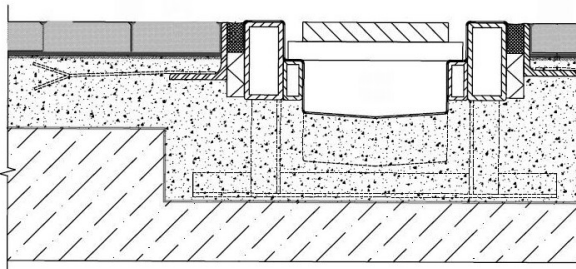
Wall floor interfaces



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Drain/ sub-floor interfaces?



EHEDG Building design 2014

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Joints

X

✓

A metal-to-metal joint is a 10 lane highway!

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Controls

X

✓

1996

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Contamination by personnel

Food workers
12% carried *L. spp*
7% carried *Lm*



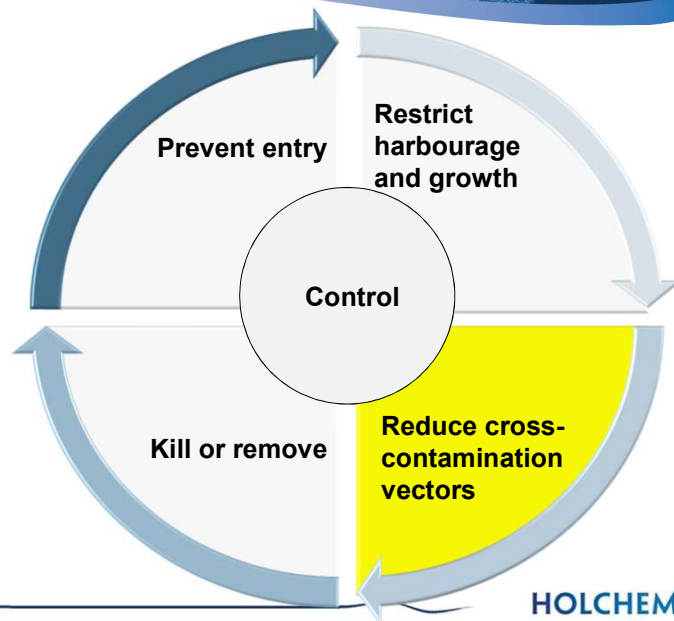
Chemical workers
No carriage

Segregation of low/high risk personnel?

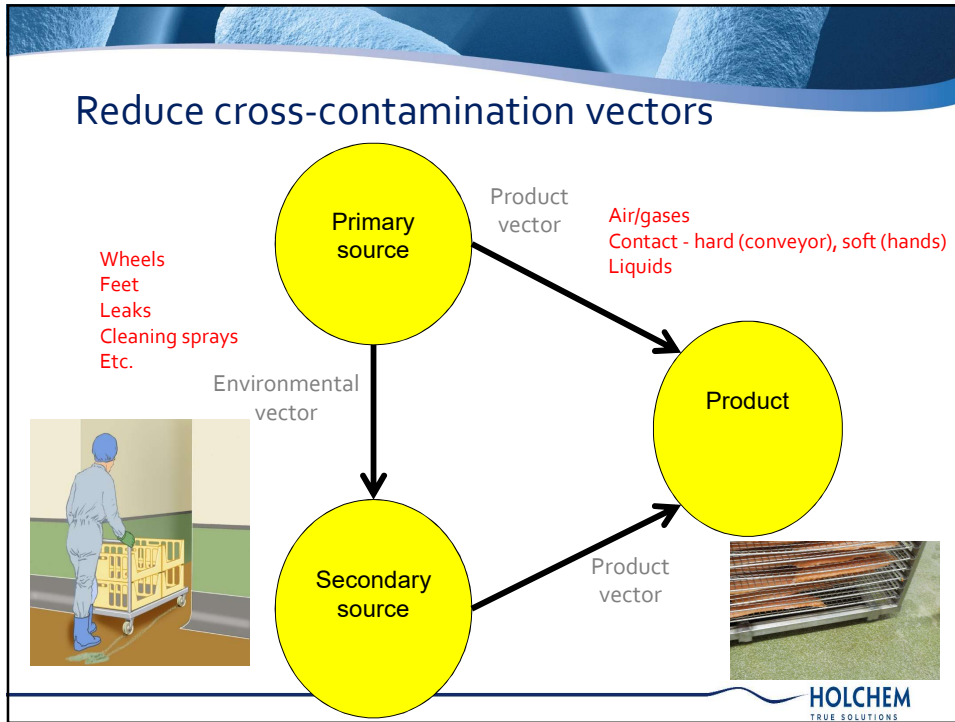
Ker et al (1993) Prevalence of *Listeria spp.* on the hands of food workers. *Journal Food Protection*, 56:525-527

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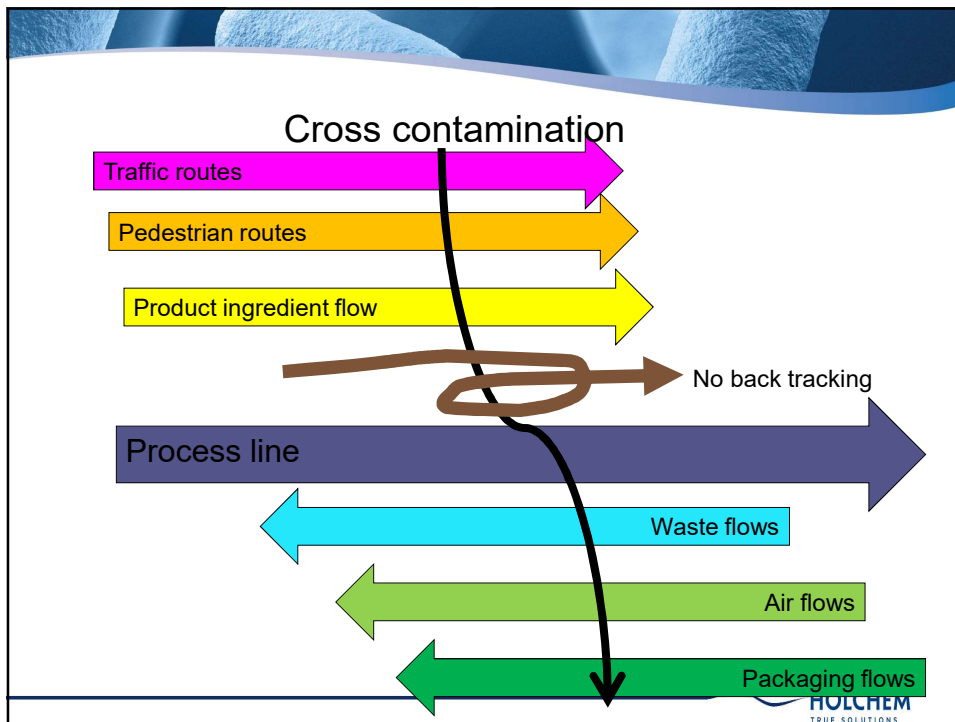
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Contamination spread by cleaning systems

Keep high risk dry during production
 Use alcohol (preferable or manual cleaning)
 Hoses used during post-production hygiene

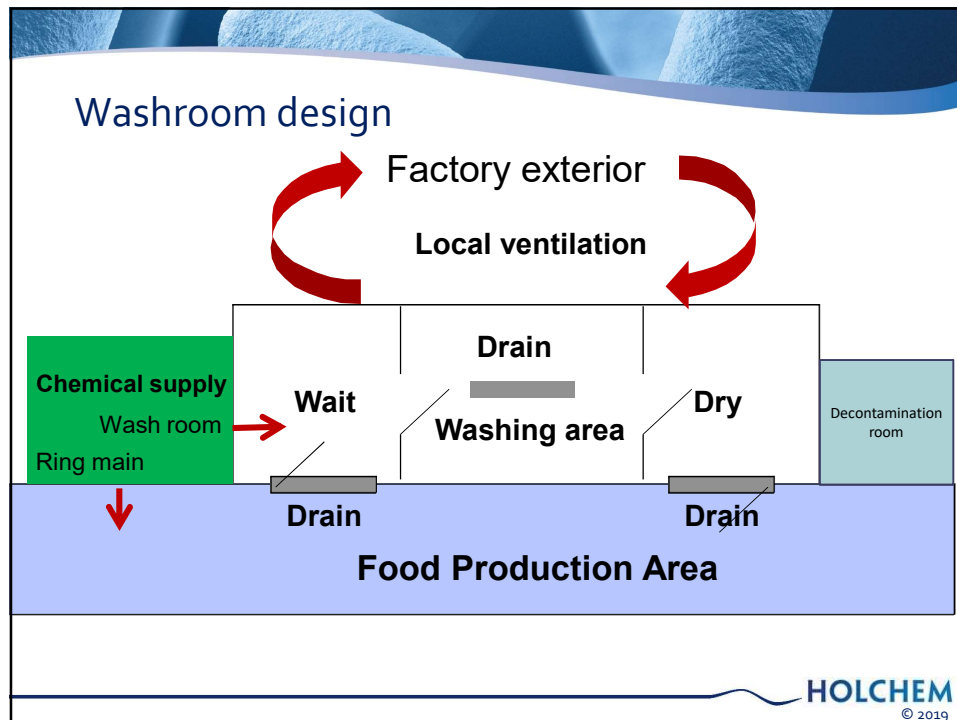


Cleaning system	Height (m)	Distance (m)
High pressure	3.55	7.0
Low pressure hose	2.25	4.0
Floor scrubber drier	0.47	1.5
Manual brushing	0.24	0.55
Manual wiping	0.23	0.35



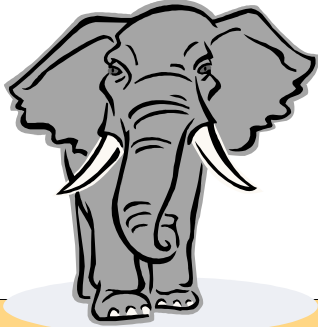
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Washroom design



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The elephant in the room?



CAUTION

50 YEAR OLD

MAY MAKE SUDDEN, DESPERATE ATTEMPTS TO APPEAR SEXY, YOUTHFUL, AND IMPORTANT

If HACCP works so well, then why are there still so many cases of food borne illness?

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Pre and post process contamination



Jensen Farms, 2011, Colorado, USA
146 cases, 30 deaths
Poor hygiene prior to washing
Failure in pre-decontamination prerequisites



Maple Leaf, 2008, Canada
57 confirmed cases, 23 deaths
Poor hygienic design of slicing machines) resulting in lack of cleanability
Failure in post-decontamination prerequisites

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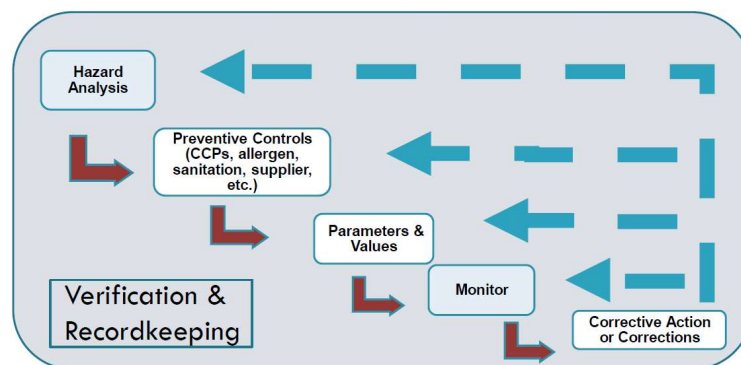
Proposed hazard analysis model

- A cheese and onion sandwich is about to be manufactured after a peanut butter sandwich. A between-batch clean has been undertaken
 - An operative on the line is not wearing a hair net.
 - The line still has peanut residues on it
 - What would you do! Would you stop the line?
- As part of Prerequisite Management, develop a Processing Environment Plan
- Reduce terminology - use the same 14 principles of the HACCP plan (Campden BRI Guideline No.42)
- **US approach is HARPC (Hazard Analysis and Risk-Based Preventive Controls)**
- <https://www.foodsafetymagazine.com/enewsletter/haccp-vs-harpc-a-comparison/>

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Listeria Management Plan

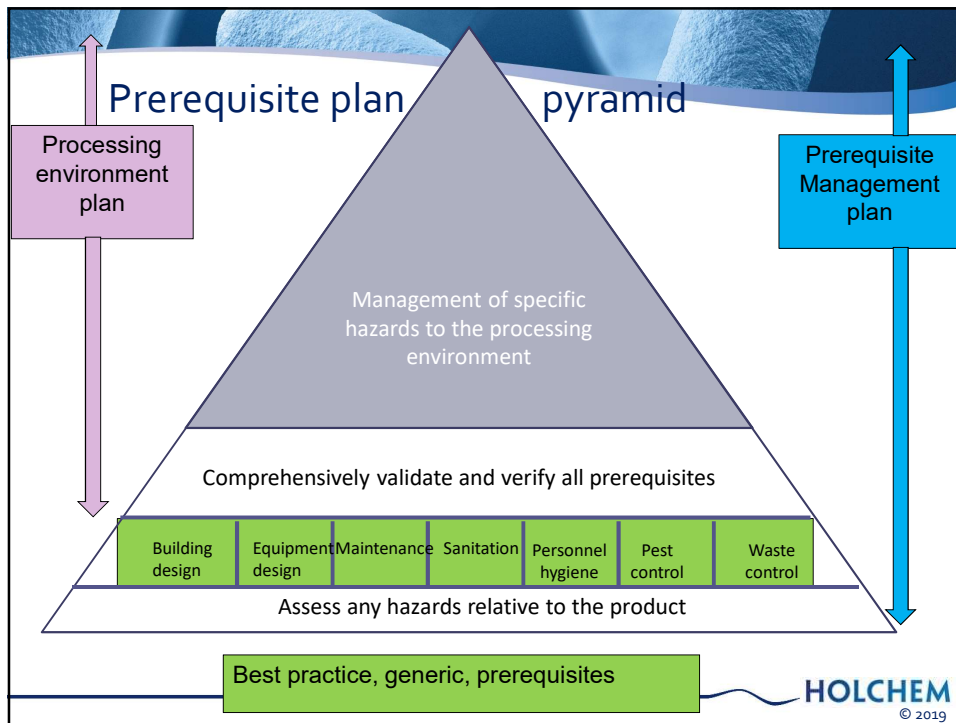


Food Safety Modernization Act (FSMA)

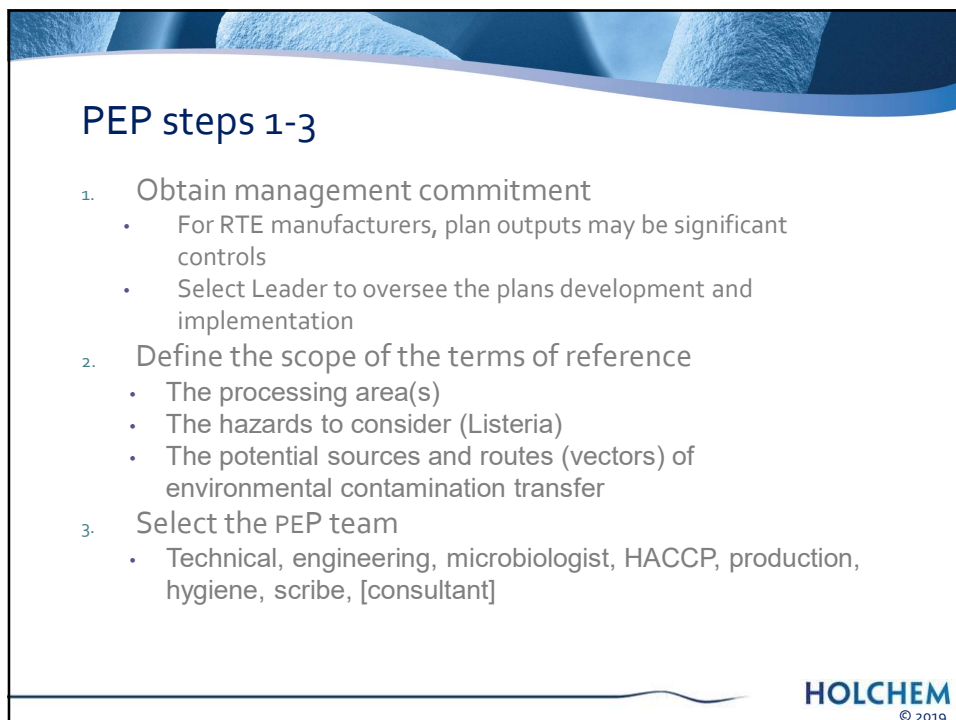
<https://www.fda.gov/downloads/food/guidanceregulation/fsma/ucm584807.pdf>

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PEP steps 4-5

4. Describe the environment
 - Size, zones, boundaries, barriers, services, air flows, temperatures, humidity, people flows, transport flows, liquid and solid waste flows
 - Production periods, sanitation procedures, shut downs
 - Historical sampling and observational data e.g. microorganisms, pests, glass
5. Identify intended use
 - Further treatments: removal, reduction or growth
 - Consumer: target consumer group

PEP steps 6-7

6. Construct flow diagram
 - Base layer of processing area, equipment and services
 - Overlaying plans of e.g. air flows, people movement, transport movement, waste flows
7. On-site confirmation of flow diagram
 - Sign off diagram(s) as an accurate representation of the processing area and activities

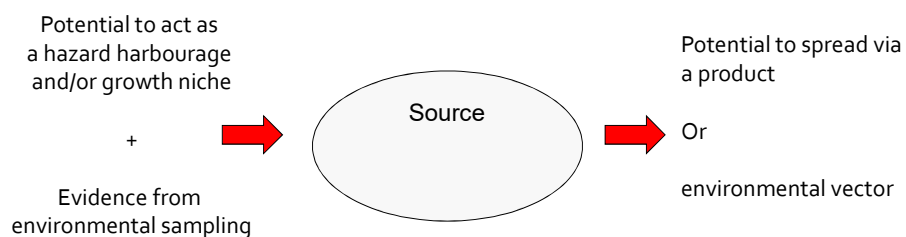
PEP step 8

8. List all potential hazards, conduct a hazard analysis and consider any measures to control the identified hazards
 - Undertake factory study by LMP team to investigate the defined sources and vectors of environmental and product contamination
 - Sources:- history internal, history external, extensive microbiological sampling.
 - Vectors:- visual assessments and discussions with staff re: all line interventions; physical measurements e.g. of airflow
 - Determine (any) current control options for the identified sources and vectors. Suggest additional/new control options.
 - Assess the need for control validation and verification

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Risk concept for sources



The risk associated with a source is concerned with both the potential of the hazard to be present at the source and, if present, their ability to be disturbed and transfer to the product directly (proximity may be important) or to the process environment


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Risk ranking for sources

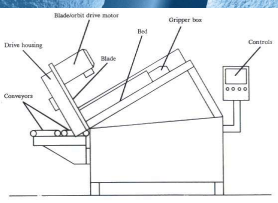
The Potential Occurrence X Potential spread = Risk Score

Risk score	Overall risk level	Control
6-9	Very high	Control critical
4	Medium	Control (SOP)
1-3	Very low	No control necessary

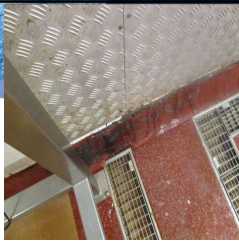


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Consider hazard sources

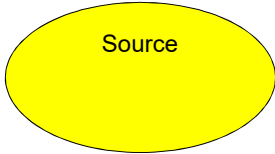


Process step or process activity	Observation	Likely hazard	Sources risk assessment without controls		Risk score	Current or intended source controls	Sources risk assessment with controls		Risk score
			Likelihood of hazard presence LMH	Potential to spread via environmental vectors LMH			Likelihood of hazard presence LMH	Potential to spread via environmental vectors LMH	
Meat slicing	Meat residues were seen on the inside of a switch that operated the machine. If <i>Listeria</i> was present in the switch, it could be transferred to the meat by the operatives finger. Microbiological sampling in the switch was always negative	Listeria	M	L	2	Switches routinely cleaned as part of the end of production sanitation practice	L	L	1
Meat slicing	Fluids were seen oozing out from the joint between the wall and coving. The immediate doorway floor area is a heavy traffic area for personnel and vehicular traffic. Environmental monitoring occasionally identified <i>Listeria</i> spp.	Listeria	H	H	9	Every shift hypochlorous acid is sprayed around the wall/coving joint	M	H	6

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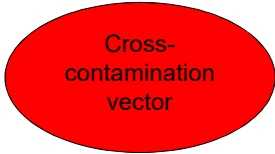
Risk concept for vectors

Potential for the hazard to be present at the source




→

Frequency of the transfer vector




Note:- a series of vectors could be considered together as a contamination event. For example a contamination event could be entrance into a dryer for cleaning. In this case the transfer vectors may be cleaning equipment, feet, clothing and hands




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Consider hazard vectors




Process step or process activity	Observation	Likely hazard	Contamination event vector(s)	Product vector risk analysis without controls		Risk score	Subsequent control step	Current or intended vector controls	Product vector risk analysis without controls		Risk score
				Potential presence of hazard on vector LMH	Frequency of event LMH				Potential presence of hazard on vector LMH	Frequency of event LMH	
Meat slicing	Joints on the slicer bed harbour debris. They are impossible to access without total slicer dismantling	Listeria	Lm has been identified in joints	H	H	9	None	Partial dismantling and cleaning and disinfection every night. Steaming every 2 weeks	L	H	3



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PEP step 9

9. Determine Operational prerequisites
 - Determine whether any hazards will be removed by subsequent control steps
 - Determine whether, in the absence of controls, any risks are so significant that they could be described as Operational Prerequisite
 - An OP should have the same 'status' as a CCP




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Consider hazard sources


Process step or process activity	Observation	Likely hazard	Sources risk assessment without controls		Risk score	Current or intended source controls	Sources risk assessment with controls		Risk score
			Likelihood of hazard presence LMH	Potential to spread via environmental vectors LMH			Likelihood of hazard presence LMH	Potential to spread via environmental vectors LMH	
Meat slicing	Meat residues were seen on the inside of a switch that operated the machine. If <i>Listeria</i> was present in the switch, it could be transferred to the meat by the operatives finger. Microbiological sampling in the switch was always negative	Listeria	M	L	2	Switches routinely cleaned as part of the end of production sanitation practice	L	L	1
Meat slicing	Fluids were seen oozing out from the joint between the wall and coving. The immediate doorway floor area is a heavy traffic area for personnel and vehicular traffic. Environmental monitoring occasionally identified <i>Listeria</i> spp.	Listeria	H	H	9	Every shift hypochlorous acid is sprayed around the wall/coving joint	M	H	6



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Consider hazard vectors



Process step or process activity	Observation	Likely hazard	Contamination event vector(s)	Product vector risk analysis without controls		Risk score	Subsequent control step	Current or intended vector controls	Product vector risk analysis without controls		Risk score
				Potential presence of hazard on vector (L/M)	Frequency of event (L/M)				Potential presence of hazard on vector (L/M)	Frequency of event (L/M)	
Meat slicing	Joints on the slicer bed harbour debris. They are impossible to access without total slicer dismantling	Listeria	Lm has been identified in joints	H	H	9	None	Partial dismantling and cleaning and disinfection every night. Steaming every 2 weeks	L	H	3
OPR											

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PEP steps 10-11


10. Establish control or operating limits
 - Likely to be factory based, potentially critical (but unlikely)
 - Measurable or observable relative to control
11. Establish a monitoring system
 - Detection of any loss of control prior to food being cross contaminated
 - E.g. ATP, protein, allergen, pH, chemical concentration, temperature
 - Establish any national reference methods
 - Authority, competence, training

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PEP step 12-14


12. Establish a corrective action plan
 - Defined actions, product hold procedures
13. Verification
 - Validation of plan
 - Validation of any essential controls
 - Environmental sampling plan
 - Verification by e.g. microbiological testing
 - Audit, trend analysis, customer complaints
 - Review – any process or processing environment changes
14. Establish documentation and record keeping
 - All records to demonstrate effective control to customers



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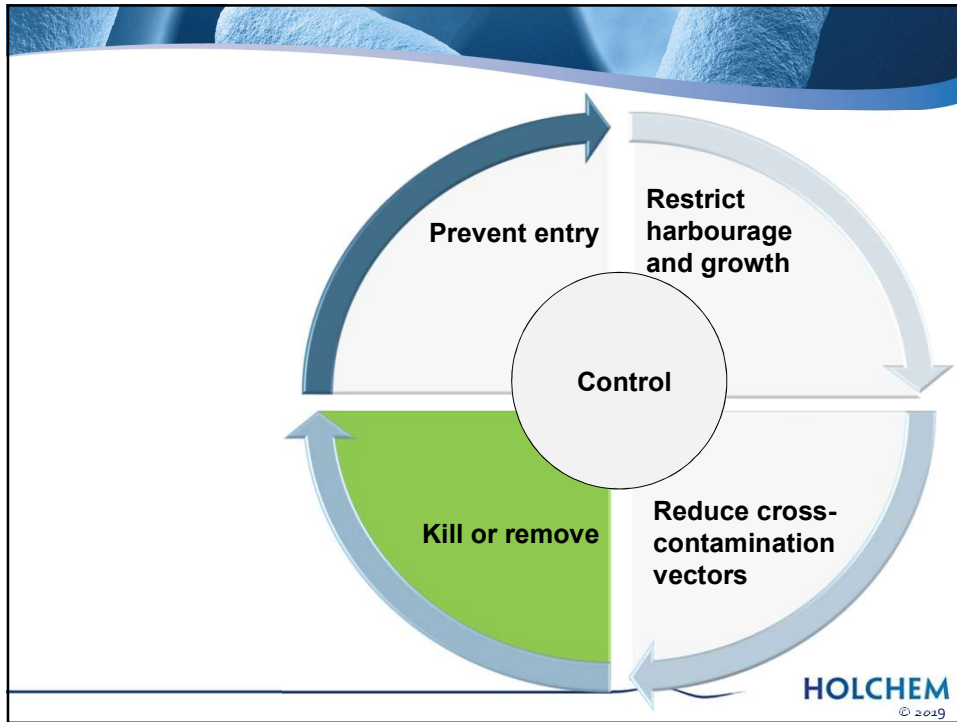
OPR management sheet



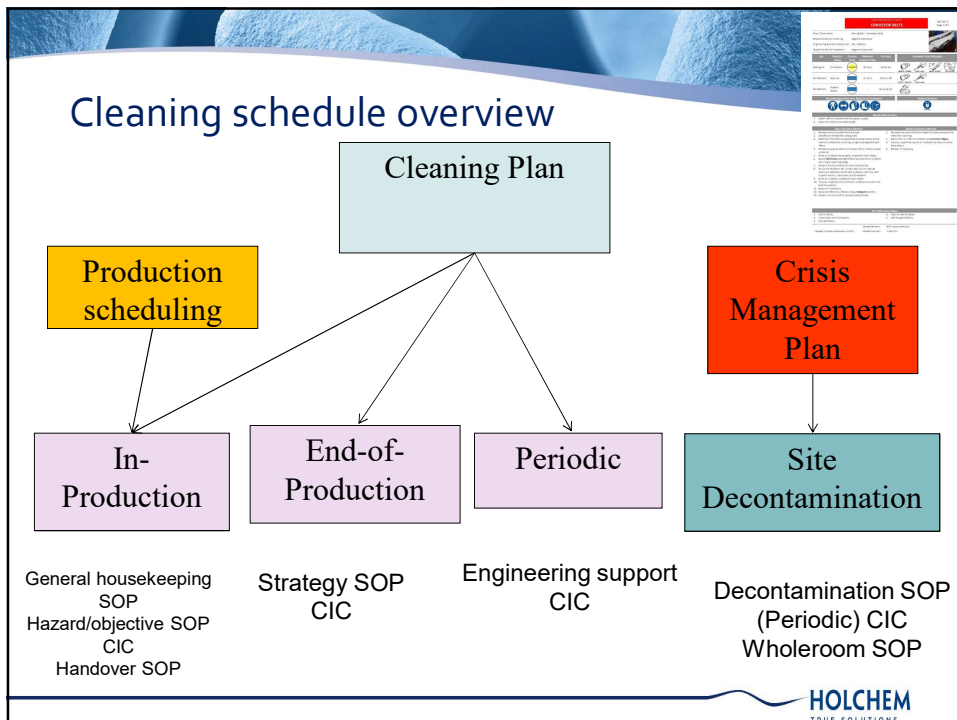
Process step or area	Likely hazards	Source or Contamination event vector(s)	Control measure(s)	Operating limit(s)	Control monitor(s)	Control verification(s)	Corrective action(s)	Records
Meat slicing	Listeria	Transfer of Lm from slicer bed to product during slicing	Cleaning until visual cleanliness ATP testing prior to disinfection Attachment of thermocouples Encasement of slicer and ancillary components in plastic bag Overpressure of sensitive components Steaming until thermocouples read 70°C and then for a further 30 minutes Drying until moisture free	ATP <150 RLU 70°C 30 min	Visual assessment of freedom of debris ATP assessment prior to disinfection Monitoring of time and temperature	Microbiological verification of slicer bed Thermocouple calibration Timer calibration Steam pressure	Staff retraining Recalibration	Visual cleanliness, ATP and microbiological records Temperature and time records Steam pressure records Calibration records

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End of production

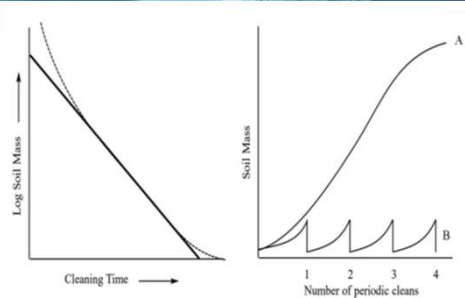
- Handover from production to hygiene
 - Defined cleaning window
 - Removal of all product and packaging
- Sequence
 - Gross solids removal, rinse, Listeria sources (e.g. drains), environment, equipment
- Chemical rotation
 - pH not disinfectants
- Cleaning validation – worst case scenarios
 - Hygienic design dead zones, most difficult to remove soil, minimal acceptable cleaning programme

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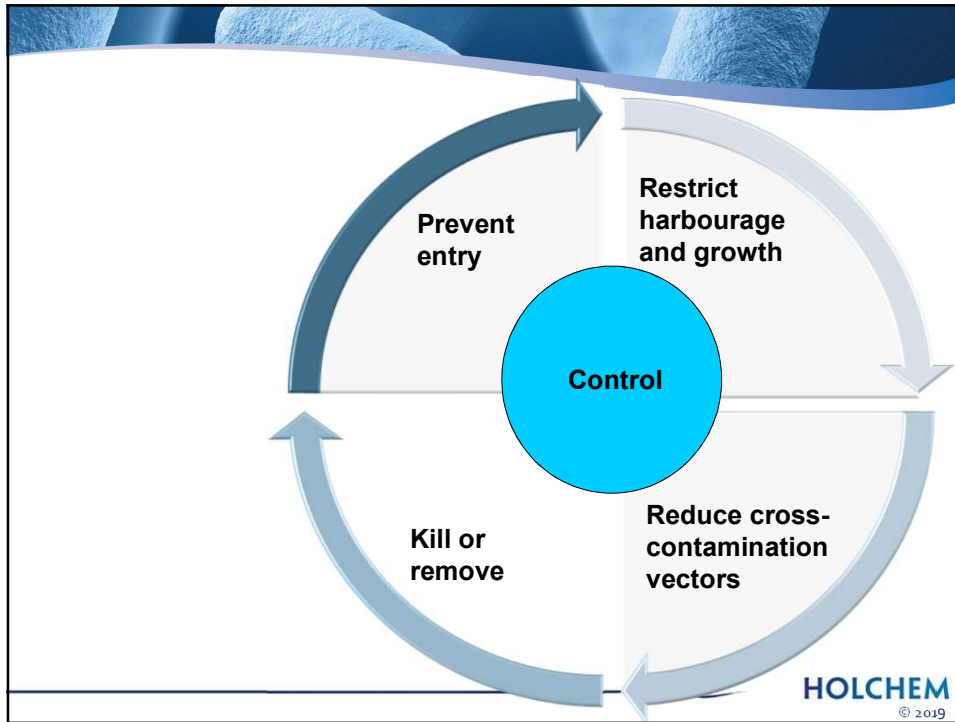
Periodic cleaning

- Cleaning is not 100% efficient so soil will accumulate with time
- Periodic cleans are required
 - Additional energy
 - Additional strip down
 - Alternative chemicals e.g. scale removal (acid clean)
 - Heat



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Sampling principles

All samples must have a purpose

- What is your corrective action if the sample is positive?

Size matters

- Large sponge/wipe samples to maximise detection e.g. on collectors
- Small swabs to focus on identified areas that are difficult to clean

Validated sampling techniques

- Listeria method ISO 17025 accredited
- Laboratory undertakes proficiency tests
- Ability to neutralise disinfectants
- Ability to maintain captured pathogens viability

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Sampling strategy

Are the barriers preventing pathogen entry?

- Sample around barriers during the day e.g. personnel changing, product entry tunnels, air supply and verify performance

Is everything under control during production?

- Sample known/suspected sources and transfer vectors – are they in control?
- Sample collector points e.g. footwear, tote wheels, cleaning equipment, drains – is there any evidence of the presence of a pathogen?
- Investigative studies if yes

Do we have pathogen free processing equipment for subsequent production?

- Verify cleaning and disinfection performance

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Environmental sampling plan maturity

Listeria – I will find you and I will kill you!

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Lm Prevalence in RTE Foods

Food processing (best practice)		Chilled Food Association
High risk	High care	Membership data base
0.1%	0.2-0.5%	~1.0%
0.1-0.3% best practice		
1.0 average – improve GMPs		
>1.0% - concern, locate source, seek and destroy		
>10% raw materials, Lm growth		

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Sampling site vs Lm detection rate

Sample site	Sample position	Sample position
Barriers	10	
Source/vector control	10	
Collectors	10	
Cleaning verification	70	
Detection rate	<0.1%	

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Sampling site vs Lm detection rate

Sample site	Sample position	Sample position
Barriers	10	10
Source/vector control	10	10
Collectors	10	70
Cleaning verification	70	10
Detection rate	<0.1%	>0.2%

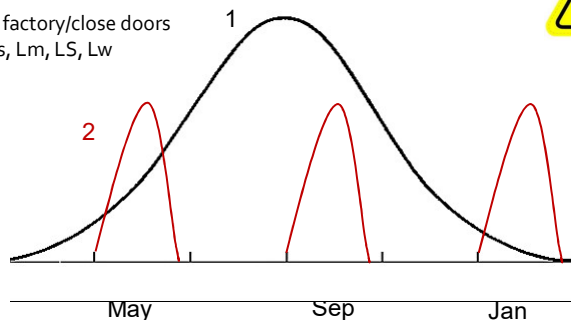
If Lm is from an environmental source env. Lm 2-3x product Lm
 If Lm is from a raw material source product Lm > env Lm

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Environmental/product Listeria patterns

1, Barriers

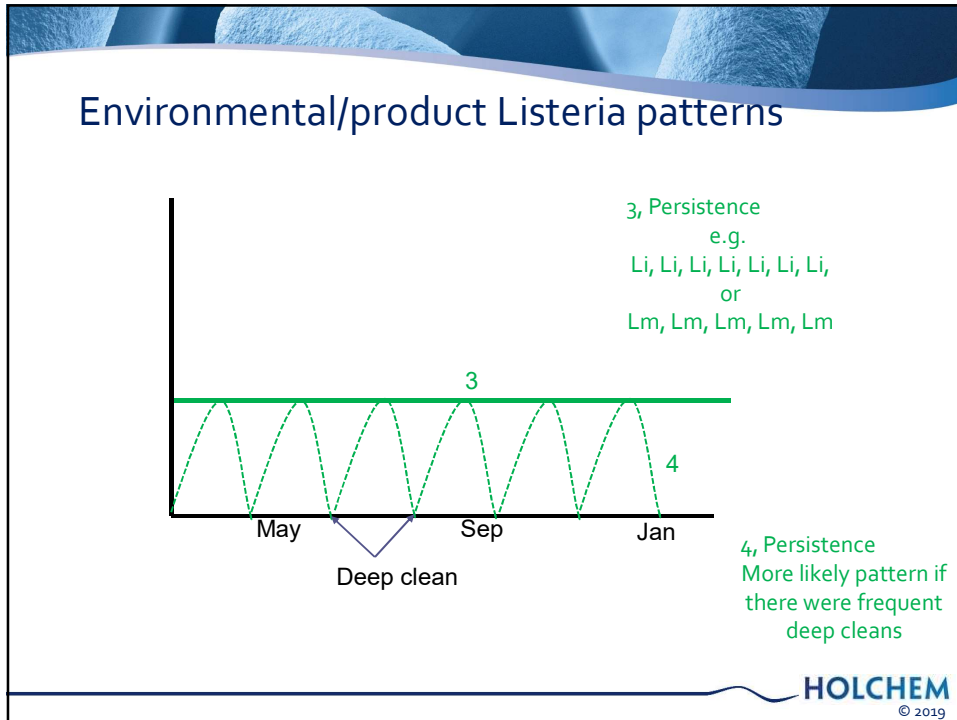
- Elevated temperatures
- High dust levels
- Limit movement into factory/close doors
- Multi-species Li, Lj, Ls, Lm, LS, Lw



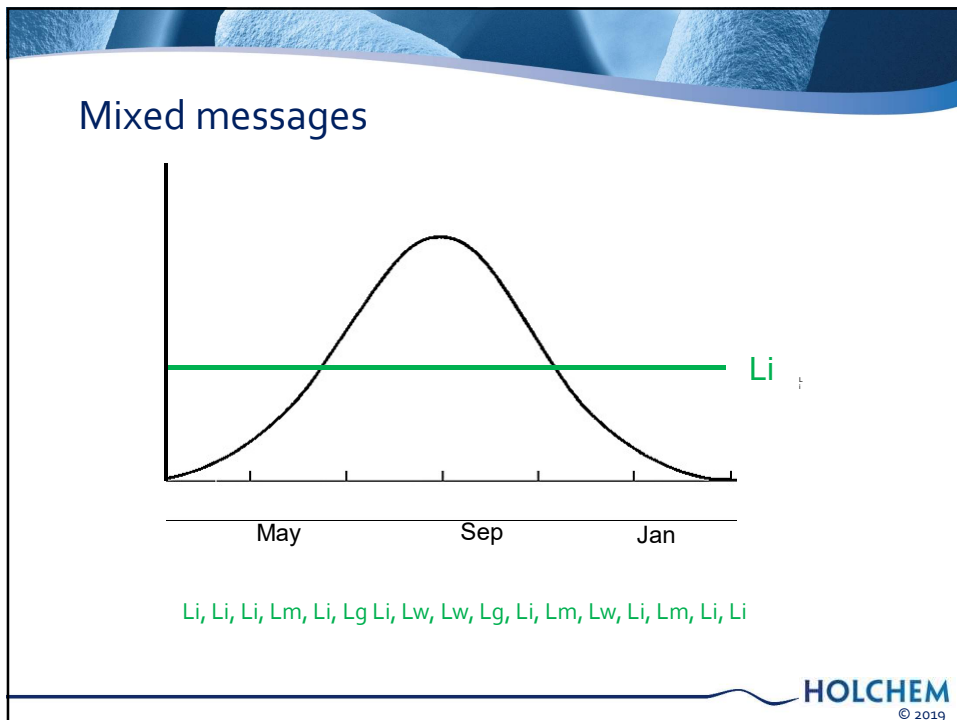
2, Ingredient batch

- Ingredient used at end of growing season
- Specific supplier from a number supplying the same ingredient (closeness to shore, well boat)

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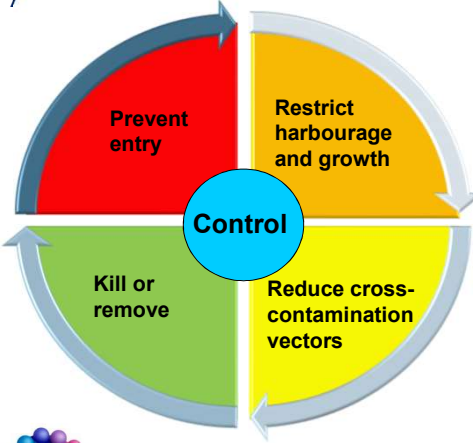

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Listeria 5 point plan – key learnings

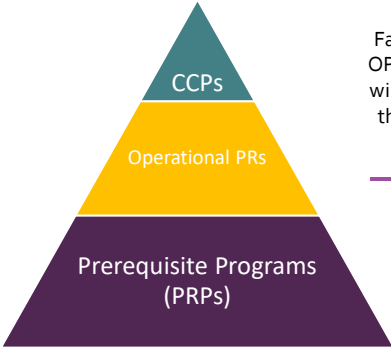
- Stop Listeria entering high hygiene
 - **Technical**
- Provide an infrastructure that does not harbour Listeria
 - **Engineering**
- Prevent Listeria moving from sources to product or the environment
 - **Production**
- Remove Listeria at defined time intervals
 - **Hygiene**

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PEP – key learnings



Failure of a CCP (process) or OP (processing environment) will result in a high likelihood that product may contain a food safety hazard

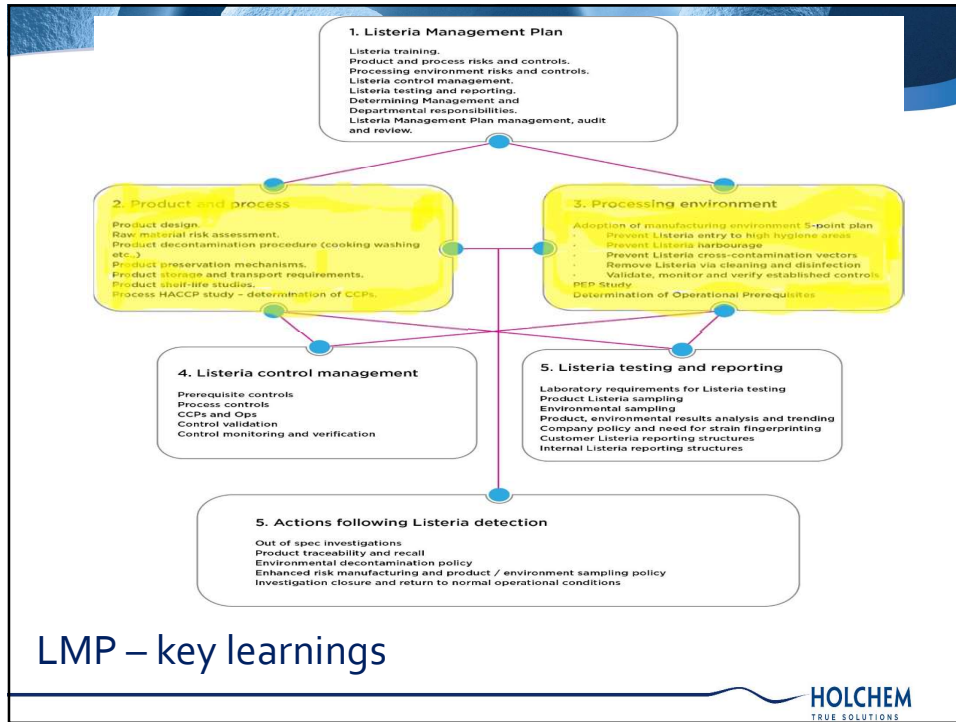
Failure of a PRP may occur without immediate impact on product safety

HOLAH, J, et al (2011) HACCP – the rise of the prerequisites. *New Food* 14,11-15

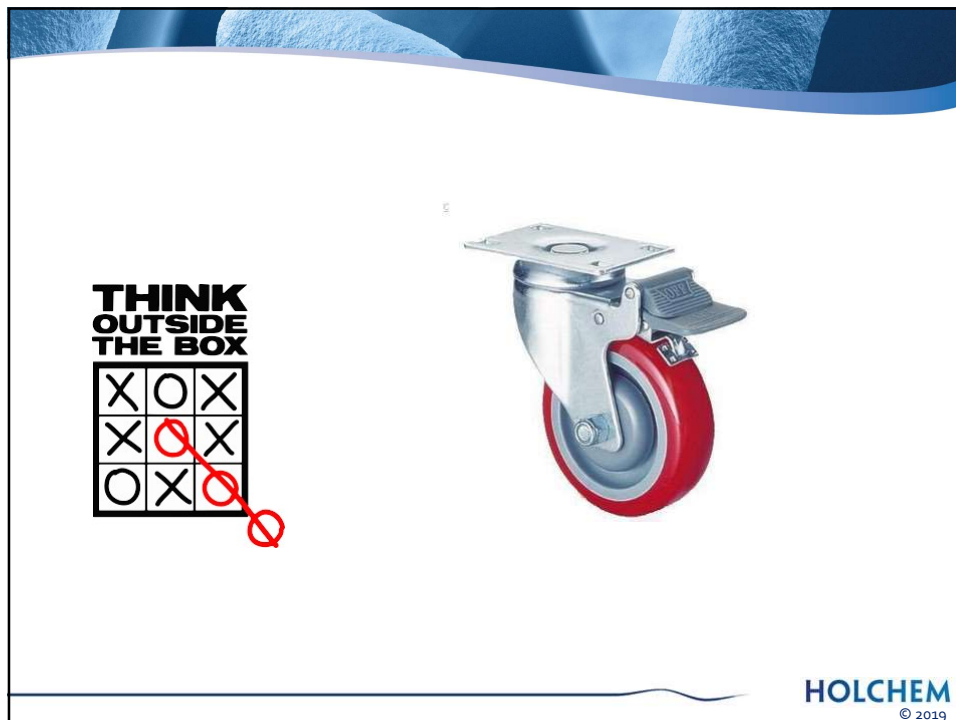
HOLAH, J, et al (2012) Identifying and Controlling Microbiological Cross-Contamination: A Risk-Based Approach to Understanding the Critical Role of Prerequisite Programs. *Food Safety magazine*, February/March 2012

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Think outside the box

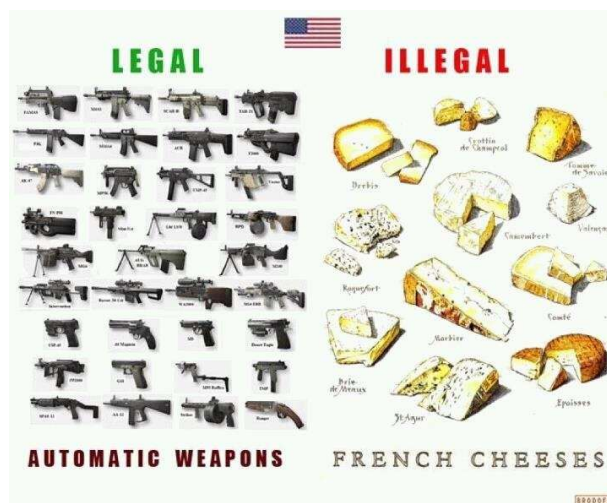
- An environmental vector
- A product vector
- A collector
- A source (if damaged)



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Realistic risk assessment?



Listeria
control in
context!

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Any Questions?



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<https://www.holchem.co.uk/about/downloads/>

Environmental Sampling Plan
Listeria Management Plan



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