• Food Hygiene

HACCP: CRITICAL CONTROL POINTS and CRITICAL LIMITS

State: January 24, 2005

- **Terms relating to CRITICAL CONTROL POINT (CCP)**

- **Control (verb)** means to taken all necessary actions to ensure and maintain compliance with criteria established in the HACCP plan.

- **Control (noun)** means the state wherein correct procedures are being followed and criteria are being met.

- **Control Measure** means any action and activity that can be used

  - to prevent or
  - to eliminate a food safety hazard or
  - to reduce it to an acceptable level

- **Critical** a few points (the 'vital few') in a specific food system where loss of control may result in a not acceptable probability of a health risk.

- **Critical Control Point** means a step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level. Determining the CCPs is principle 2 of the HACCP-System.

- **discussion / conclusion**

  In some languages the root of the word “control” is understood in the sense of “to check” or “to examine”. This wrong interpretation leads to misunderstanding of the CCP-concept. A CCP is a step where it is possible to keep a hazard under control. To watch or check this point is called “Monitoring”

- ***CCP 1 and CCP 2***

  The ICMSF proposed two kinds of CCPs:

  CCP 1: ***Completely elimination of microbiological hazard(s)***

  CCP 2: ***Minimizing of microbiological hazard(s)***

- ***discussion / conclusion***

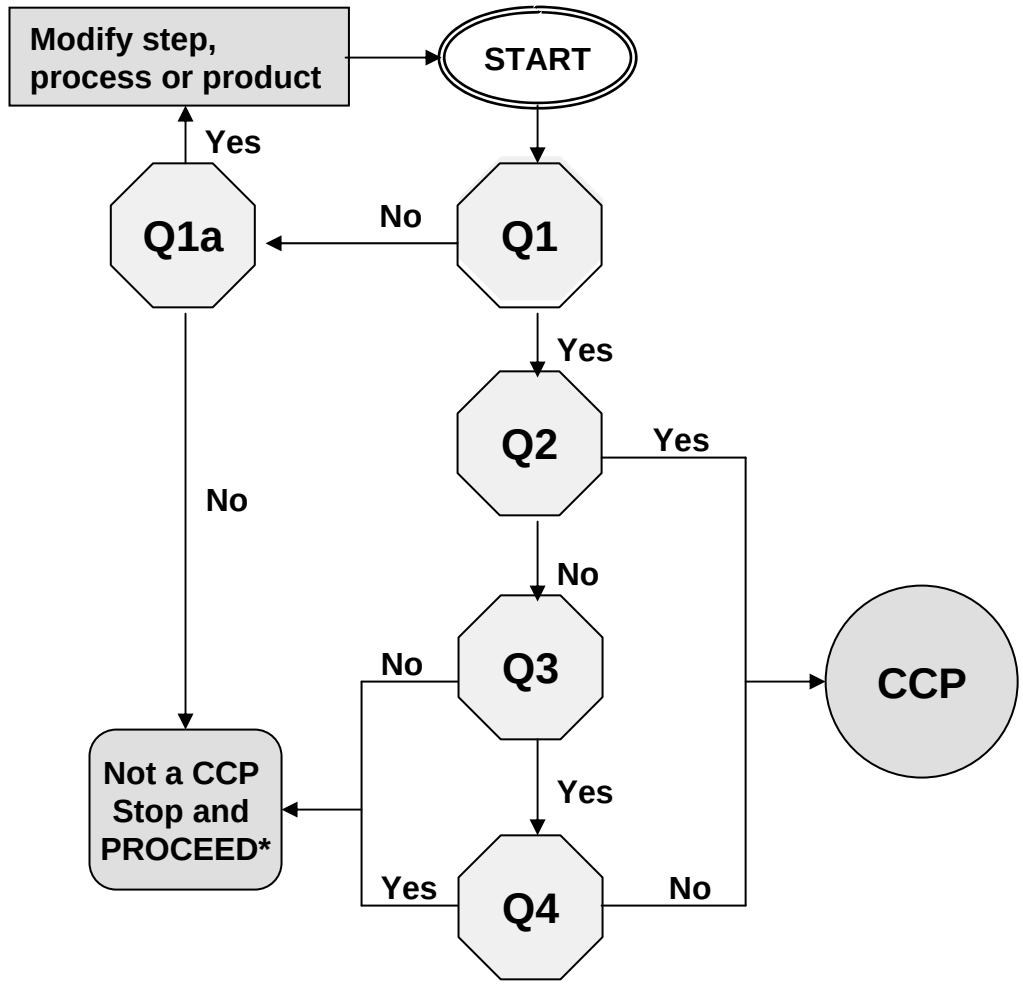
  Complete elimination of a risk is theoretically impossible.. For this reason and because of psychological objections the differentiation between “important” CCP 1 and “less important” CCP 2 was abandoned.

  Now numbering of CCPs characterizes their position in a longitudinally integrated safety assurance system.

- **Diagram to identify CCPs in the flow chart of the processing line**

Apply HACCP decision tree to each step (answer questions in sequence)

- **Q1 - Could Preventive Measure(s) (PM) exist?**
- **Q1a - Is a Preventive Measure necessary at this step for food safety?**
- **Q2 - Is the step specifically designed to eliminate or reduce the likely occurrence of a hazard to an acceptable level?**
- **Q3 - Could contamination with identified hazards occur in excess of acceptable levels or could these increase to unacceptable level(s)?**
- **Q4 - Will a subsequent step eliminate identified hazards or reduce likely occurrence to an acceptable level?**

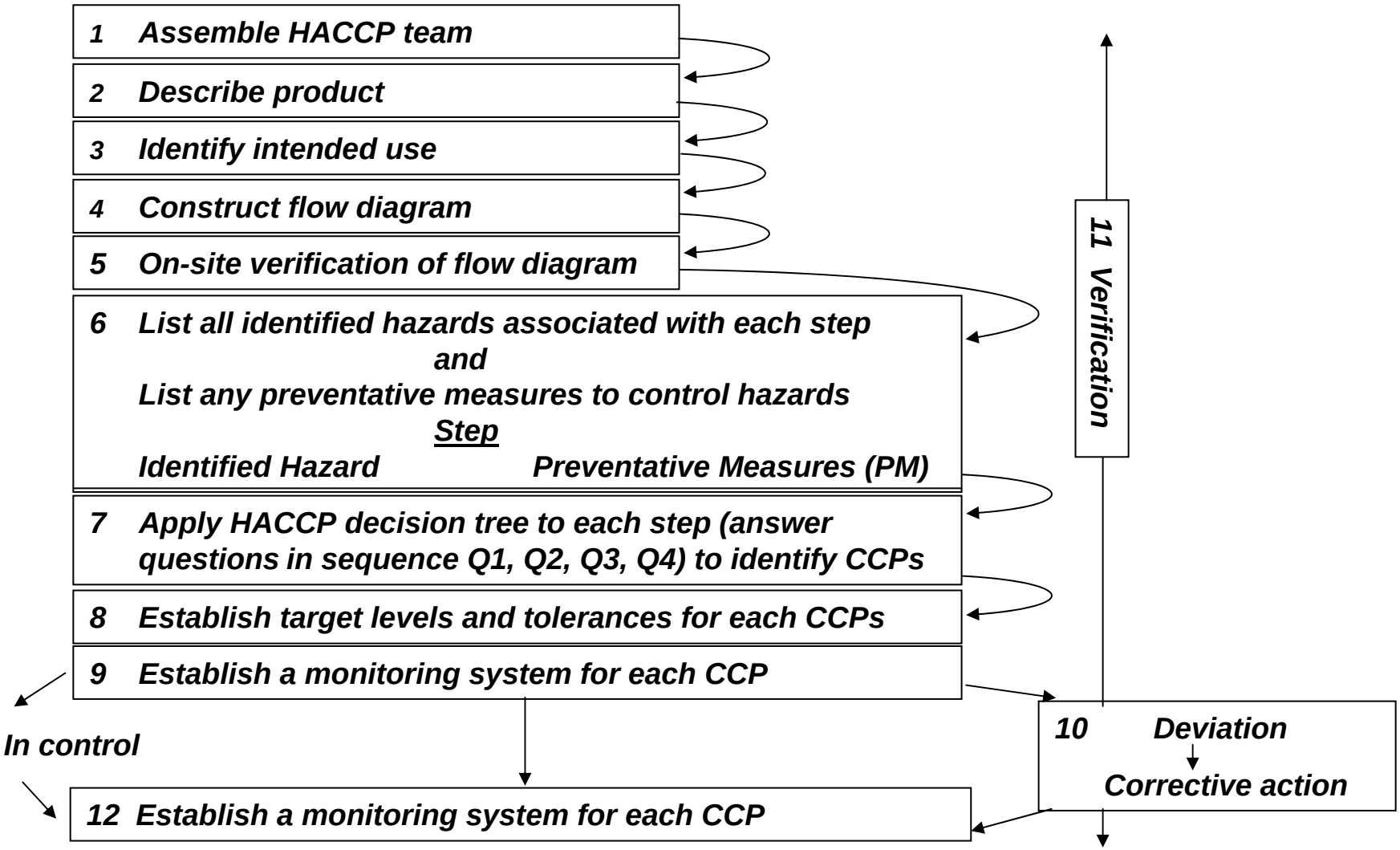


***** Proceed to next step in the described process

- **Important considerations when using the decision tree:**

- **The decision tree is used after the hazard analysis.**
- **The decision tree then is used at the steps where a hazard that must be addressed in the HACCP plan has been identified.**
- **A subsequent step in the process may be more effective for controlling a hazard and may be the preferred CCP.**
- **More than one step in a process may be involved in controlling a hazard.**
- **More than one hazard may be controlled by a specific control measure.**

- ***Position of principle 2 (= determining CCPs) in the sequence for application of HACCP***



- **Handling and Processing acting as CCPs: Effects on microbes**

Operation	Food	Intended effect
Cleaning, washing	All raw foods	Reduces numbers of microbes
Antimicrobial dipping / washing	Mostly fruits, vegetables	Kills selected microbes
Chilling (below 10°C)	All foods	Prevents growth of most pathogenic bacteria; slows growth of spoilage microbes
Freezing (below -10°C)	All foods	Prevents growth of all microbes
Freeze drying	Meals, vegetables, shrimps	Prevents growth of all microbes
Pasteurizing (60-80°C)	Milk, wines, etc.	Kills most non-sporing bacteria, yeast and moulds
'Blanching' (95-110°C)	Vegetables, shrimps	Kills vegetative bacteria, yeast and moulds
Canning (above 100°C)	Canned foods	'Commercially sterilized' food, kills all pathogenic bacteria
Drying	Fruit, vegetables, meat, fish	Halts growth of all microbes when aw < 0.60
Salting	Vegetables, meat, fish	Halts growth of many microbes at ca. 10% salt
Syruping (sugars)	Fruits, jam, jellies	Halts growth when aw < 0.70
Acidifying	Fermented dairy and vegetable products	Halts growth of most bacteria (effects depend on acid type)
Preservative (in the strict sense)	Many different foods	slows growth of yeasts, moulds and other microbes
Irradiating	Spices, shrimps, poultry, etc.	Destroys or 'sterilizes' according to dose
Controlled atmosphere	Packed foods	Halts growth of aerophilic microorganisms

Annotation: Preventing or halting growth does not act as CCP in every case (e.g. Salmonella typhi in drinking water)

- **Traditional control measures the have been used for making commercially prepared foods safe**

Food	*Process*	*Food*	*Process*
Milk	*D, H*	*Vegetable juices*	*B, D*
Eggs	*E*	*Vegetables, pickled*	*A*
Natural cheese	*J*	*Peanut butter*	*I*
Processed cheese and cheese sauce	*C*	*Ham, bacon*	*A, E*
Cake, bread	*K, L*	*Beef*	*B, E*
Cookies, crackers	*H*	*Pork sausage*	*E, G*
Fruit	*A, C, J, H*	*Dry and semi-dry sausage*	*E, F, G*
Fruit juices	*C, D*	*Franks, viennas, meat spreads*	*B*
Jams, jellies	*C*	*Luncheon meats, cured*	*A*
Vegetables	*A, B, H*	*Fish, smoked salmon, pickled herring, salt cod*	*B, E, H*

Process Codes:

A. *Mild thermal process (F_0 = < 2.78) in hermetically sealed container.*
B. *High thermal process (F_0 = ≥ 2.78) in hermetically sealed container.*
C. *Thermal process, hot fill, seal and hold before cooling.*
D. *Thermal process, chill, then aseptically package.*
E. *Salted, perhaps curd, at low temperature then dried during heating or at ambient temperatures. Smoke commonly applied.*
F. *Fermented at 20 - 40°C, perhaps heated to ≥ 46°C, then dried at cool temperature (e.g., 13°C).*
G. *Fermented and/or cooked, dried, then sealed in lard.*
H. *Thermal process and dehydration.*
I. *Roasted, ground and filled at moderate temperature.*
J. *Dehydration.*
K. *Filled into container, sealed, then heated sufficiently to bake product.*
L. *Baked in container, then sealed while hot.*

- **discussion / conclusion**

  If one control measure does not reduce a hazard to an acceptable level, it is necessary to combine two or more measures simultaneously or successively (hurdle technology)

- **New and emerging control measures for preservation of food**

- **Physical processes**

  Gamma and electron beam ionizing irradiation
  - **radicidation: doses sufficient to eradicate parasites and microbial pathogens**
  - **radurization: for "radiation pasteurization" of foods**
  - **radappertization: doses sufficient to achieve sterility of foods**

  Application of high hydrostatic pressure
  - **to inactivate vegetative microorganisms, extend shelf life, and improve safety**

  Application of high-voltage electric pulses
  - **to inactivate vegetative microorganisms in liquid foods**

  Combined ultrasonication, heat and slightly raised pressure ("manothermosonication")
  - **to reduce the temperature necessary for pasteurization or sterilization of liquid foods**

  Application of high-intensity laser or noncoherent light pulses
  - **to rapidly decontaminate clear liquid foods and food and packaging surfaces**

  Application of high magnetic field pulses

- **Natural additives**

  Animal-derived antimicrobials
  - **hen egg white lysozyme, to prevent growth from spores of *Clostridium tyrobutyricum* in cheeses**
  - **lactoperoxidase system, to improve keeping quality of milk**
  - **lactoferrin, lactoferricin**

- **Plant-derived antimicrobials**
  - **herb and spices extracts**

- **Products of microorganisms**
  - **bacteriocins, nisin, pediocin**
  - **other bacteriocins and culture products**
  - **antimycotics, natamycin/pimaricin**

- **Performance Criteria**

  To achieve the defined FSO, it is necessary to implement one or more control measures at one or more steps (Critical Control Points) in the food chain. At these steps, hazards can either be prevented, eliminated, or reduced. If appropriate control measures are not applied at these steps, then the hazards may increase. **The outcomes of these control measures are defined as performance criteria.**

- Examples of published performance criteria include:

  - 12 D reduction of proteolytic *Clostridium botulinum* in low-acid canned foods
  - 6 D reduction of *Listeria monocytogenes* in ready-to-eat chilled foods
  - 6 D reduction of psychrotrophic strains of *Clostridium botulinum* in pre-prepared chill-stored foods with extended shelf-life
  - 5 D reduction of *Escherichia coli* O157:H7 for fermented meat products

- A **Performance Criterion** is preferably less than but at least equal to the FSO and can be expressed by the following equation:

$$H_0 - \Sigma R + \Sigma I \leq FSO$$

Where: FSO = Food safety objective

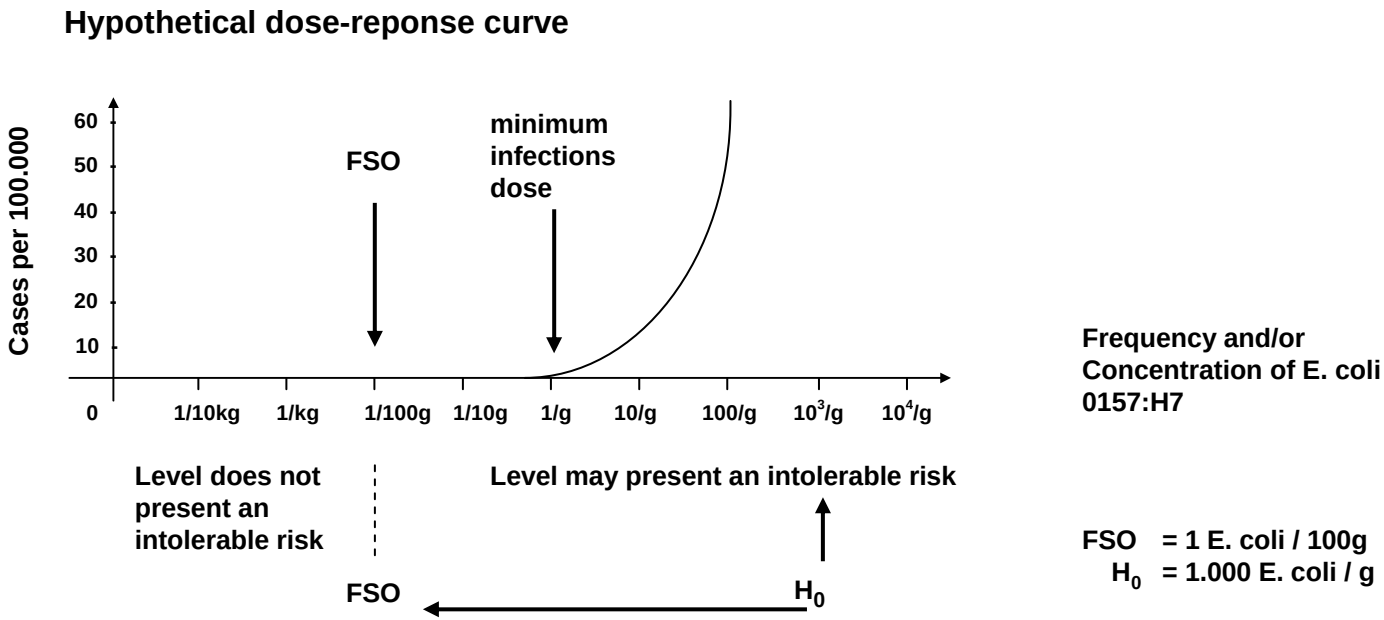
H_0 = Initial level of the hazard

ΣR = Total (cumulative) reduction of the hazard

ΣI = Total (cumulative) increase of the hazard

FSO, H_0 , and I are expressed in $\log_{10}$ units.

- **Examples of Performance criteria**
- **Example 1: Mortadella type sausage contaminated with E. coli 0157:H7**

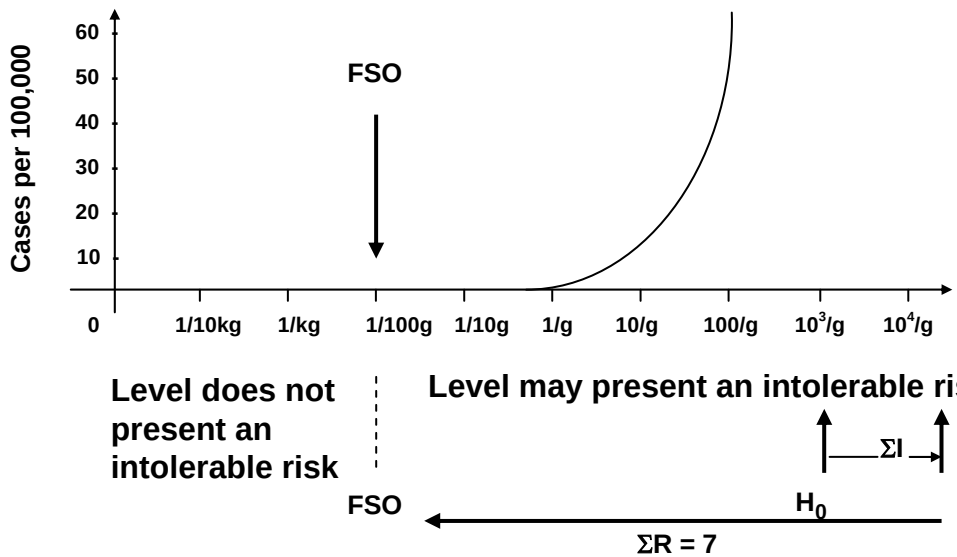


- **Requirement:** $H_0 - \Sigma R + \Sigma I \leq FSO$

- **discussion / conclusion:** $H_0 - \Sigma R + \Sigma I \leq FSO \Rightarrow 3 - \Sigma R + 0 \leq -2$

  $\Sigma R \leq -5$
- **Performance Criterion:** 5D - Reduction by heating
- **Additionally the initial contamination of the raw material should be reduced (= lowering H_0)**

- **<u>Example 2</u>: Same situation as Example 1, but growth of E. coli (ΣI) leading to not more than a 100-fold increase during processing is possible.**



Frequency and/or Concentration of E. coli 0157:H7

$$H_0 - \Sigma R + \Sigma I \leq FSO$$

$$3 - \Sigma R + 2 \leq -2$$

$$\Sigma R \leq -7$$

Performance Criterion: 7 D - Reduction by heating

- **discussion / conclusion**

Three “P”-criteria which should not be confused

- **Performance criterion**

  The required outcome of a step, or combination of steps, that contribute to assuring a food safety objective is met.

- **Process criteria**

  The control parameters of a step, or combination of steps, that can be applied to achieve a performance criterion.

- **Product criterion**

  A parameter of a food that can be used to assess the acceptability of a lot or consignment.

- **Terms related to CRITICAL LIMIT**

- **Critical limit** **means a criterion which separates acceptability from unacceptability.**

  Critical limits (comparable with "Process criteria" in QM-terminology) are the control parameters (e.g., time, temperature, pH, a_w) at a CCP or combination of CCPs that can be applied to achieve a Performance criterion.
  For example, the Control parameters for mild pasteurization

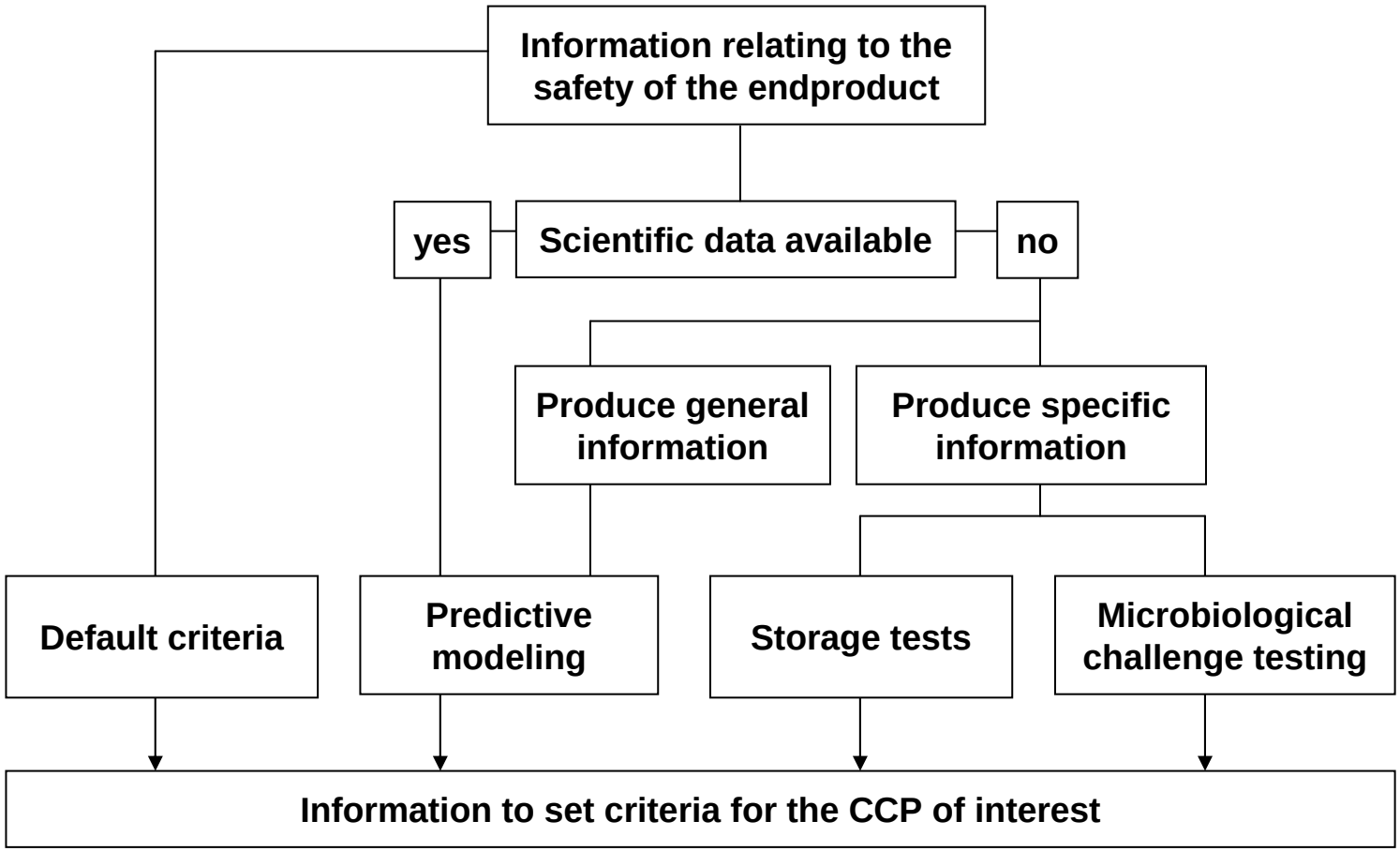
  are 62-65 °C / 30-32 min
  or 72-75 °C / 15-30 sec
  or ≥ 85 °C / ≤ 4 sec.

  These combinations of temperature and time will ensure the destruction of Coxiella burnettii, as well as other non-spore-forming pathogens that are known to occur in raw milk.
  Critical limits must be specified and validated.

- **Deviation** **means a failure to meet a critical limit.**

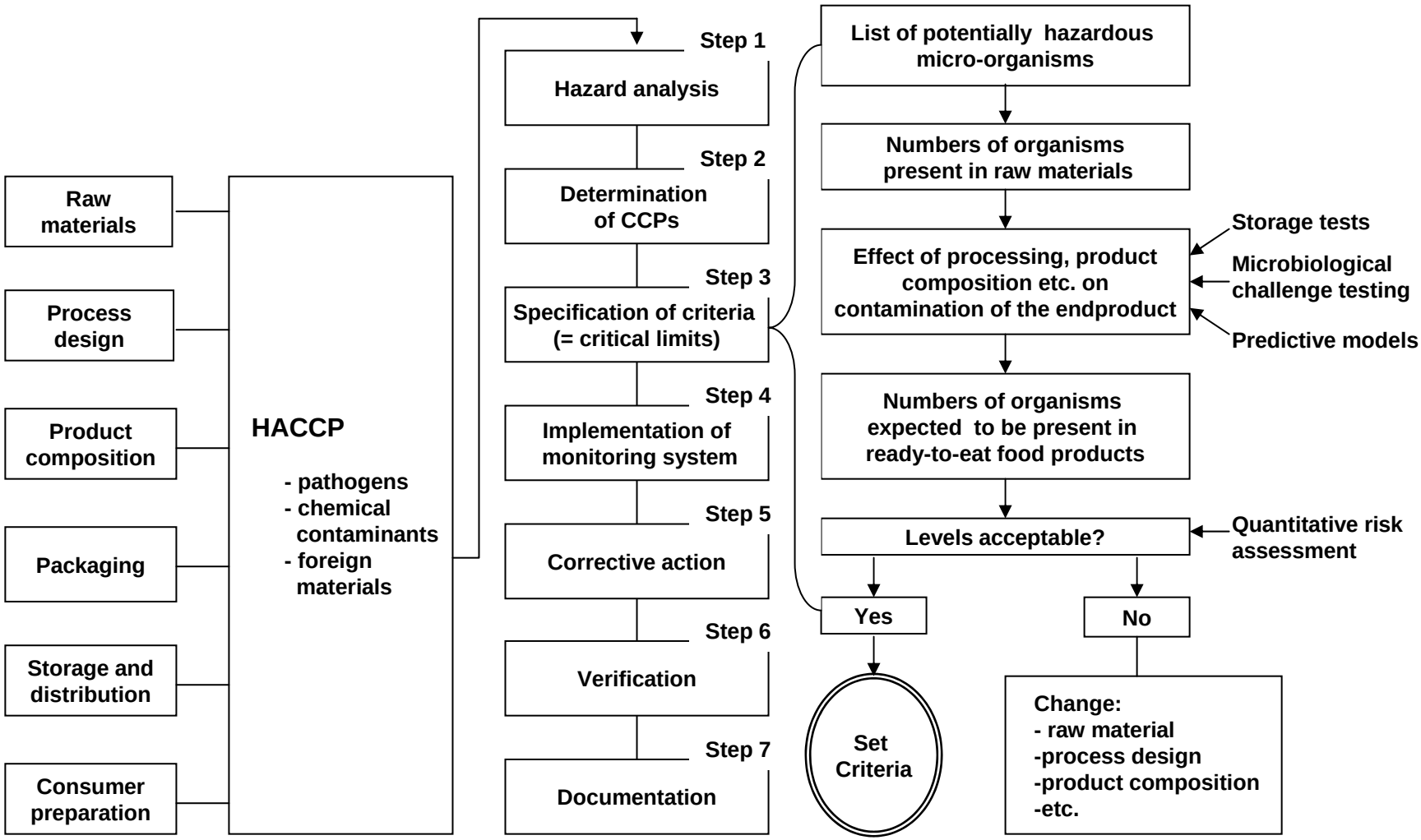
- ***Default criteria*** ***mean conservative values established to ensure the safety of a process or a food. If insufficient resources are available to perform the research needed to arrive at sound process or product criteria, then default values can be applied. An example of a default value is heating for 10 min at 90 °C internal temperature to destroy nonproteolytic C. botulinum in extended shelf-life ready-to-eat chilled foods. Default values have most commonly been developed by control authorities or advisory groups. The values specify the minimum criteria that must be met to ensure the production of safe food.***

- **Generation of information necessary to establish criteria for Critical Control Points.**



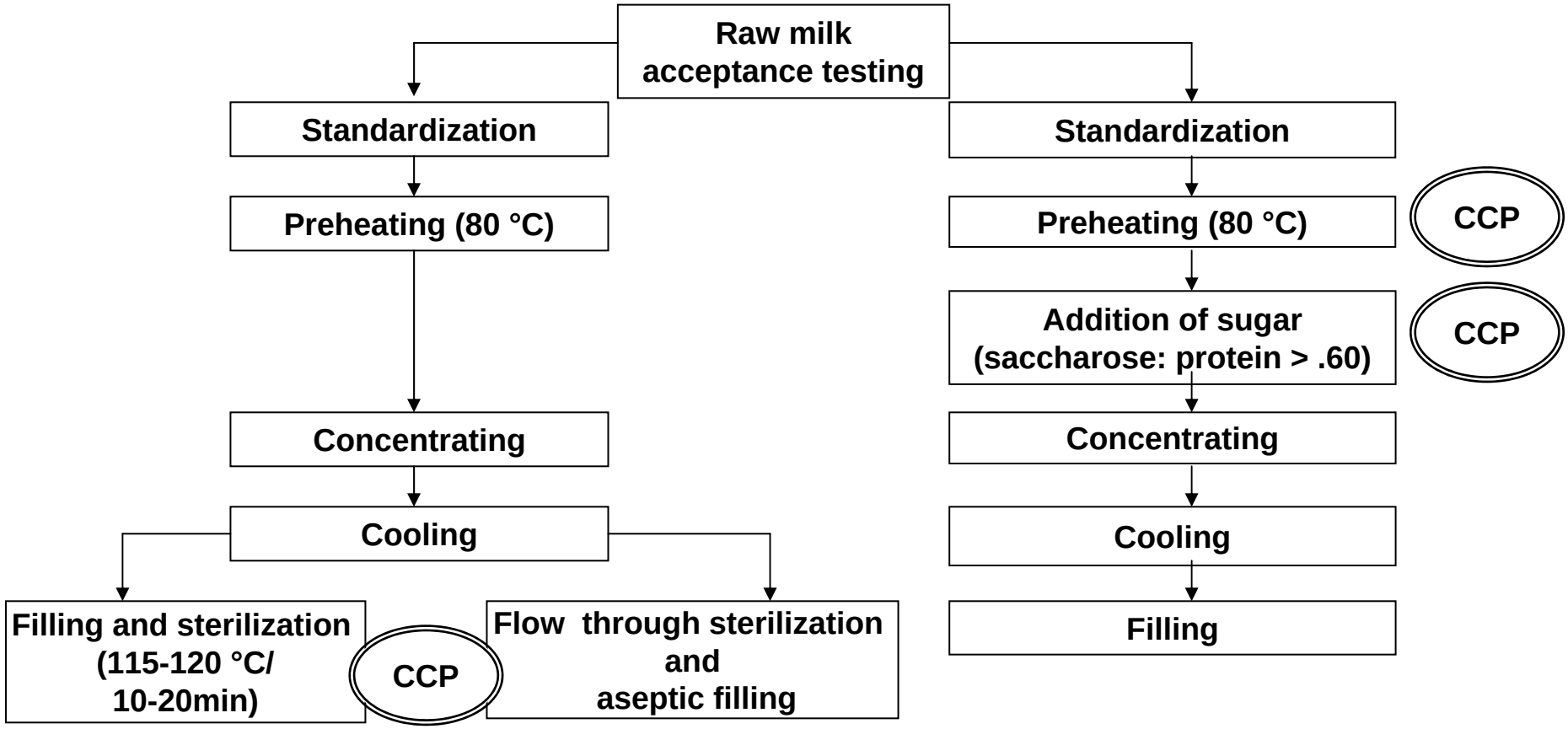
- **Proposed approach to set Critical Limits at Critical Control Points.**

(Notermans and Mead 1996)



- **Example for HACCP-principles 2 and 3:**

Flow diagram for the production of evaporated milk with and without sugar



- **discussion /conclusion**

Because of Maillard-reactions it is not possible to sterilize sugared evaporated milk at 115-120 °C/ 10-20 min for inactivation of *Cl. sporogenes*. The growth of this sporeforming germ is prevented by the combination of two CCPs (preheating and content of sugar).