

Code of practice for

Pasteurization of milk on farms and in small dairies

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Committees responsible for this British Standard

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- British Association for Chemical Specialities
- Department of Agriculture Northern Ireland
- Department of Health
- Department of Trade and Industry (Laboratory of the Government Chemist)
- Health and Safety Executive
- Milk Marketing Board
- Milk Marketing Board for Northern Ireland
- Ministry of Agriculture, Fisheries and Food (ADAS)
- National Farmers' Union
- Scottish Office Agriculture and Fisheries Department
- Society of Dairy Technology

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Foreword

This British Standard has been prepared under the direction of the Consumer Products and Services Sector Board at the request in particular of the Department of Health; Ministry of Agriculture, Fisheries and Food; the United Kingdom Milk Marketing Boards and the National Farmers' Union.

This code of practice is intended for the use of manufacturers, suppliers and installers of equipment; for purchasers and producer processors or operators of small dairies; and for those involved in the approval and checking of plant and milk quality and safety.

As a code of practice, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

The BSI Committee wishes to acknowledge the assistance of the Society of Dairy Technology who have given permission to use information from their Pasteurizing Plant Manual in this text.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 76, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Section 1. General

1.1 Scope

This British Standard gives recommendations for the process principles, design features and operation of equipment used on individual farms by producer processors and in small dairies for the pasteurization of cows' milk by means of the holder (batch) and continuous flow (HTST) methods.

Guidance is given on the requirements of UK and EEC legislation for dairies concerning pasteurized milk. Guidance is also given on the hygienic and control measures used in the pasteurization process and packaging operations which are necessary to achieve safety and high quality in pasteurized milk.

For convenience a list of the legislation referred to in this standard is given in Annex A. A bibliography of relevant publications is given in Annex B.

This standard does not cover specific recommendations for the pasteurization of cream, ice cream or flavoured milks.

NOTE Levels of heat treatment in this standard are not necessarily appropriate for cream, ice cream and flavoured milks. Separation of milk for other products should be undertaken before pasteurization.

1.2 References

1.2.1 Normative references

This British Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on the inside back cover. For dated references, only the edition cited applies; any subsequent amendments to or revisions of the cited publication apply to this standard only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

1.2.2 Informative references

This British Standard refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

1.3 Definitions

NOTE The meaning of terms used in the United Kingdom legislation concerning milk production, pasteurized milk, semi-skimmed and skimmed milk and pasteurized milk-based drink or milk drink, is given in individual items of legislation. Persons responsible for milk production and milk processing operations should be aware of the legal interpretation of the terms used in dairy legislation.

For the purposes of this British Standard, the following definitions apply.

1.3.1

approved chemical agents

disinfecting agents or detergent/disinfectants approved jointly for use in England and Wales by the Minister of Agriculture, Fisheries and Food and the Secretary of State for Social Services and the Secretary of State for Wales

NOTE 1 Chemical disinfectant agents approved for use in England and Wales may be used in Northern Ireland.

NOTE 2 In Scotland, the Secretary of State approves chemicals for use as bactericidal agents in dairy applications.

1.3.2

available chlorine

the quantity of chlorine equivalent to the oxygen released when the chlorine containing disinfecting agent is completely decomposed to chloride and oxygen

NOTE The use of the term "available chlorine" is confined in practice to liquid hypochlorite and solid chlorine-releasing agents in which the disinfecting action follows a ready hydrolysis to hypochlorous acid and its subsequent decomposition to chloride and oxygen.

1.3.3

buffering

stabilizing the pH value of a solution

1.3.4

chilled water

clean water at a temperature of less than 5 °C

1.3.5

cleaning

the process of removing soil

1.3.6

cleansing

as in various milk and dairies legislation, a combination of cleaning and disinfecting processes

1.3.7

clean water

water that, at the point of use, is of a quality sufficient to conform to the classification set out in the UK Water Supply (Water quality) Regulations 1989 which implement the provisions of EEC Directive 80/778/EEC 1980 "Quality of water intended for human consumption"

1.3.8

coliforms

bacteria, which at 30 °C, can ferment lactose with the production of gas under the conditions specified

NOTE Coliforms do not survive pasteurization. They are common contaminants of improperly cleansed equipment.

1.3.9

corrosion inhibitors

substances capable in specific instances of minimizing the corrosion of certain metals

1.3.10**dairy establishment**

dairy premises used for the treatment, processing, collection or standardization of milk

1.3.11**detergents**

substances capable of assisting cleaning when added to water

NOTE They include soaps, organic surface-active agents, e.g. synthetic detergents, alkaline materials and, in certain circumstances, acids.

1.3.12**disinfection**

a process that reduces the number of bacteria in dairy plant and utensils to a level consistent with acceptable quality control and hygienic standards

1.3.13**disperse**

to bring into (and keep in suspension) undissolved soiling matter

1.3.14**emulsify**

to bring into (and keep in dispersed form) oils and fats from the milk residue

1.3.15**farm pasteurizer**

term used in Northern Ireland to identify a milk producer who processes and sells pasteurized milk(s)

1.3.16**fogging**

the application of a disinfecting agent in the form of a dense mist of minute droplets

1.3.17**holder (batch) pasteurization**

a non-continuous method of achieving pasteurization conditions for milk and milk products

1.3.18**HTST (continuous) pasteurization**

the high-temperature short-time method for continuous-flow pasteurization of milk and milk products

1.3.19**keeping quality of pasteurized milk**

the time required for pasteurized milk to become unacceptable to a consumer, because of the development of an undesirable off flavour or a physical instability in the milk

1.3.20**methylene blue test**

a dye reduction test which measures the extent of bacterial contamination and its activity in pasteurized milk

1.3.21**milk churn**

synonymous term for milk can

1.3.22**milkstone**

a deposit that contains calcium caseinate and calcium phosphate

1.3.23**peroxidase test**

a method which determines whether or not milk has been heated during the pasteurization process to a temperature above 78 °C at which point the enzyme is inactivated

1.3.24**phosphatase**

an enzyme that is always present in raw milk and that is inactivated by the time-temperature combination necessary for pasteurization

1.3.25**plate count**

the number of bacteria and other micro-organisms which are present in a sample of milk and are viable and countable under the conditions of the test

1.3.26**production holding**

premises which have been approved for the production and sale of raw milk

1.3.27**producer processor**

a milk producer who processes and sells pasteurized milk(s) through retail outlets such as shops

1.3.28**producer retailer**

a milk producer who processes and sells pasteurized milk(s) either retail direct to customers or semi-retail to caterers, hospitals and other institutions

1.3.29**psychrotropic bacteria**

those bacteria which are capable of appreciable growth at about 6 °C, irrespective of their optimum growth temperature

1.3.30**sequestering agents**

chemicals that combine with calcium and magnesium salts, such as those occurring in hard water, to form water-soluble compounds, generally enhancing the detergent operation

1.3.31**soil**

the milk residue, scale and other deposits of soiling matter that have to be removed from plant and containers during the cleaning process

1.3.32**sterilization**

a process intended to destroy all living organisms

1.3.33**surface-active agents**

substances capable of modifying the physical forces existing at surfaces, such as between liquids and solids, permitting more intimate contact and facilitating their mixing

1.3.34**swabbing**

the application of a liquid to a surface by means of a cloth or other absorbent material

1.3.35**thermization**

heating of milk for at least 15 s at a temperature between 57 °C and 68 °C such that after treatment the milk shows a positive reaction to the phosphatase test

1.3.36**thermoduric bacteria**

organisms which survive pasteurization

1.3.37**unopened pack**

a completely sealed container, which has not had its contents exposed to possible environmental contamination

1.4 International definitions**1.4.1 Pasteurization**

“A heat treatment process applied to a product with the aim of avoiding public health hazards arising from pathogenic microorganisms associated with milk. Pasteurization as a heat treatment process is intended to result in only minimal chemical, physical and organoleptic changes.

NOTE Pasteurization is intended to avoid public health hazards in the sense that, although it may not destroy all the pathogenic microorganisms which may be present, it reduces the number of harmful microorganisms to a level at which they do not constitute a significant health hazard. Pasteurization also extends the keeping quality of some products by reducing the number of spoilage microorganisms in the product.” (IDF D-Doc 222:1991.)

1.4.2 A pasteurized product

“A milk or a fluid milk product which has been subjected to pasteurization, which if retailed as such has been cooled without delay and has then been packaged with minimum delay under conditions which minimize contamination. The product must give a negative phosphatase test immediately after heat treatment.

NOTE A pasteurized product as defined is one which has been pasteurized as such, as distinct from a product manufactured from milk, skimmed milk and/or cream which has been pasteurized.

A negative phosphatase test is considered to be equivalent to less than 2.2 micrograms of phenol liberated by 1 millilitre of sample (IDF Standard 63:1971) or less than 10 micrograms of *p*-nitrophenol liberated by 1 millilitre of sample (IDF Provisional Standard 82A:1987).” (IDF D-Doc 170:1988.)

1.4.3 Process parameters

“Various combinations of temperature and duration of heating have an equivalent and minimum bactericidal effect necessary for the pasteurization of milk and skimmed milk.” (IDF Bulletin 292/1994. Recommendations for the hygienic manufacture of milk and milk-based products.) These combinations are 62.8 °C for 30 min by the holder (batch) process and 71.7 °C for 15 s by the HTST (continuous) method. In each case the milk is cooled without delay preferably to 5 °C or below.

Legislation requirements exist in respect of:

- a) the temperature below which the product needs to be cooled;
- b) upper limits to the temperature of heat treatment, and conformity to a test for the presence of peroxidase.

Section 2. United Kingdom and European Community legislation concerning milk pasteurization

2.1 General

The production and sale of pasteurized milk in the United Kingdom is controlled by the general provisions of the Food Safety Act 1990 for England, Wales and Scotland, and the Food Safety (NI) Order 1991 for Northern Ireland.

These Acts authorize Ministers to make regulations controlling:

- a) the conditions of milk production;
- b) the approval and use of milk establishments; and
- c) the sale of milk within specified categories.

2.2 The Dairy Product (Hygiene) Regulations 1994

These include the detailed provisions concerning a registration to produce raw milk (production holding) or an approval in relation to milk pasteurization (dairy establishment).

General statutory requirements relate to:

- a) health and housing of cattle;
- b) buildings and water supplies;
- c) arrangements for pest control;
- d) handling, filtration, cooling and storage of milk;
- e) infection of milk and protection against contamination;
- f) cleansing and storage of vessels, utensils and appliances;
- g) hygiene applicable to staff, including training;
- h) prescribed milk standards;
- i) effective heat treatment;
- j) packaging, labelling and transport.

Regulations with similar intent apply in Northern Ireland and Scotland and should be consulted.

2.3 Council Regulation (EEC) No. 1411/71

These regulations restrict the sale of milk for human consumption to the following categories:

- a) raw milk;
- b) non-standardized whole milk;
- c) standardized whole milk;
- d) semi-skimmed milk;
- e) skimmed milk.

2.4 The Consolidated Food Labelling Regulations 1994

(currently undergoing public consultation)

These regulations require all milks to be correctly marked and labelled when prepackaged and sold for human consumption.

2.5 Methods and conditions for milk pasteurization (Council Directive EC 92/46)

The occupier of a dairy establishment should be familiar with and undertake his operations according to the requirements concerning the pasteurization of milk in respect of time/temperatures of heat treatment, control of the pasteurization process, cleaning and disinfection, milk storage and transport, milk quality and packaging.

These are summarized in Table 1.

Attention is drawn to further requirements that:

- a) the critical control points in the process are identified, monitored and controlled to the satisfaction of the approving authority;
- b) such permanent records are retained, as required by the approving authority.

2.6 Statutory requirements concerning the quality of milk

Legal quality standards apply to raw milk intended for heat treatment and to pasteurized milks.

In addition to microbiological standards, statutory requirements include:

- a) that milk does not contain added water, antibiotic residues in excess of authorized levels or residues of substances harmful to human health;
- b) that pasteurized milk has been subjected to a permitted pasteurization procedure and satisfies the specified phosphatase test;
- c) that pasteurized milk shows a positive reaction to the peroxidase test as specified or, in the case of high temperature pasteurized milk, shows a negative reaction to this test;
- d) limits on the permitted storage time and temperature of raw milk prior to heat treatment.

The occupier of a dairy establishment should be aware of the statutory tests and the standards to be achieved in order to implement an effective quality control programme to ensure full compliance.

The statutory requirements are summarized in Table 2.

Table 1 — Methods and conditions for milk pasteurization

Legislation	UK legislation relating to pasteurized milk(s) prescribe the following:
Method and conditions of heat treatment	Milk has to be pasteurized — that is to say: a) obtained by means of a treatment involving a high temperature for a short time (at least 71.7 °C for 15 s or an equivalent combination); or b) a pasteurization process using different time and temperature combinations to obtain an equivalent effect, e.g. batch pasteurization: at least 62.8 °C for 30 min; c) cooled to a temperature not exceeding 6 °C as soon as practicable after pasteurization. The heat-treatment equipment has to be approved by the competent authority and fitted with: 1) an automatic temperature control; 2) a recording thermometer; 3) an automatic safety device preventing insufficient heating; 4) an adequate safety device preventing the mixture of pasteurized milk with incompletely heated milk (HTST plants); 5) an automatic recording device for the safety system referred to in 4) (HTST plants).
Cleaning and disinfection	Instruments and working equipment intended to come into direct contact with raw materials and products, have to be smooth, corrosion resistant and easy to clean and disinfect. Equipment which comes into contact with milk during production has to be cleaned and disinfected at the end of each working phase and at least once each working day. After chemical disinfection instruments and equipment have to be rinsed with potable water.
Milk storage and transport	The temperature at which pasteurized milk may be kept until it leaves the establishment has to be ≤ 6 °C and the storage temperature should be recorded. During transport the temperature of pasteurized milk cannot exceed 6 °C (this does not apply to doorstep deliveries to the consumer). Vehicles and containers used for transporting pasteurized milk have to be designed and equipped in such a way that the required temperature can be maintained. The internal surface of any vessel used to transport pasteurized milk has to be smooth, corrosion resistant and easy to clean and disinfect.
Milk quality	The pasteurized milk has to meet prescribed quality standards.
Packaging, sealing and labelling	Bottling, filling of containers with heat-treated milk and the sealing of containers and of packaging has to be carried out automatically.^a Sealing has to be carried out in the dairy establishment in which the heat treatment has been carried out immediately after filling. The health mark, nature and date of heat treatment, storage temperature and indication of durability have to be displayed.^b
^a A derogation may be granted to establishments with limited production. ^b Special dispensations may apply.	

Table 2 — Statutory requirements concerning the quality of raw and pasteurized milk

Milk	Milk storage temperature	Test	Legal quality standards
Raw milk for the manufacture of drinking milk Point of production	$\leq 8^{\circ}\text{C}$ (if not collected within 2 h of milking) $\leq 6^{\circ}\text{C}$ (alternate day collection)	Plate count at 30°C	$\leq 100\,000/\text{ml}$ Geometric average over 2 months; at least two samples per month
		Somatic cell count	$\leq 400\,000/\text{ml}$ Geometric average over 3 months; at least one sample per month
		Antibiotics residues	Council Regulation (EEC) 2377/90 (as amended) prescribes maximum residue limits
		Added water ^a	Absent. Confirmation by regular checks and sample testing
During transport	$\leq 10^{\circ}\text{C}$	—	—
Upon reception at the milk establishment	$\leq 6^{\circ}\text{C}$ if not treated within 4 h	As above	As above
Pasteurized milk (liquid consumption) Production line	$\leq 6^{\circ}\text{C}$	Plate count at 21°C after incubation at 6°C for 5 days	$< 50\,000/\text{ml}$ (m) $(n = 5, c = 1, M = 5 \times 10^5)$
		Coliforms	Absent (m) $(n = 5, c = 1, M = 5)$
		Pathogenic micro-organisms	Absent in 25 g (m) $(n = 5, c = 0, M = 0)$
		Antibiotics residues	As above
		Added water	As above
Raw milk for the manufacture of milk-based products Point of production	$\leq 8^{\circ}\text{C}$ (if not collected within 2 h of milking) $\leq 6^{\circ}\text{C}$ (alternate day collection)	Plate count at 30°C	From 1.1.94 $\leq 400\,000/\text{ml}$ From 1.1.98 $\leq 100\,000/\text{ml}$
		Somatic cell count	From 1.1.94 $\leq 500\,000/\text{ml}$ From 1.1.98 $\leq 400\,000/\text{ml}$
		Antibiotics residues	As above
		Added water	As above
During transport	$\leq 10^{\circ}\text{C}$		
If processed within 36 h of acceptance at processing establishment	$\leq 6^{\circ}\text{C}$		
If processed within 48 h of acceptance at processing establishment	$\leq 4^{\circ}\text{C}$		

^a Freezing Point Depression (FPD)
 It is important to avoid confusing the freezing point of milk given above with the FPD as expressed using the Hortvet procedure. The latter is commonly adopted in the United Kingdom resulting in a freezing point approximately -0.018°C lower, i.e. -0.538°C (Hortvet). See BS 3095.

Table 2 — Statutory requirements concerning the quality of raw and pasteurized milk

Milk-based products	Type of micro-organism	Legal quality standards
Cheese other than hard cheese	<i>Listeria monocytogenes</i>	Absence in 25 g where $n = 5, c = 0$
Milk-based products, other than cheese covered above	<i>Listeria monocytogenes</i>	Absence in 1 g
Milk powder	<i>Salmonella spp</i>	Absence in 25 g where $n = 10, c = 0$
Milk products, other than milk powder	<i>Salmonella spp</i>	Absence in 25 g where $n = 5, c = 0$
The samples of 25 g above have to consist of 5×5 g taken from different parts of the same product. Where the above standards are exceeded the products are to be withdrawn from the market and not permitted to be used for human consumption.		
Soft cheese	<i>Staphylococcus aureus</i> <i>Escherichia coli</i>	$\left\{ \begin{array}{l} n = 5, c = 2 \\ m = 100, M = 1\ 000 \end{array} \right.$
Fresh cheese Powdered milk Frozen milk products including ice-cream	$\left\{ \begin{array}{l} \text{Staphylococcus aureus} \end{array} \right.$	$\left\{ \begin{array}{l} n = 5, c = 2 \\ m = 10, M = 100 \end{array} \right.$
Where the standards for the above four categories of products are exceeded a review of the monitoring methods should be undertaken and the enforcement authority advised of corrective measures implemented.		
Whenever strains of enterotoxinogenic <i>Staphylococcus aureus</i> or strains of <i>Escherichia coli</i> which are presumed to be pathogenic are identified in dairy products, all batches involved have to be withdrawn from the market and the enforcement authority notified.		
The symbols given in Table 2 have the following meaning: n = number of sample units comprising the sample; c = number of sample units where the bacteria count may be between “ m ” and “ M ”, the sample being considered acceptable if the bacteria count of the other sample unit is “ m ” or less; m = threshold value for the number of bacteria, the result is considered satisfactory if the number of bacteria in all sample units does not exceed “ m ”; M = maximum value for the number of bacteria, the result is considered unsatisfactory if the number of bacteria in one or more sample units is “ M ” or more.		

2.7 Documentation and records

The Dairy Product (Hygiene) Regulations 1994 require records to be made and kept for inspection in respect of pasteurized milk.

It is essential that occupiers of milk establishments arrange for records to be kept in a permanent form for a period of:

- at least 2 months in respect of pasteurized drinking milk or pasteurized milk used for dairy products which cannot be stored at an ambient temperature;
- at least 2 years in respect of pasteurized milk used in the manufacture of other dairy products.

Such records relate to the monitoring of the critical controls mentioned in 2.5, and include:

- records showing the operation of the flow diversion device on continuous-flow pasteurizers;
- charts of recording thermometers installed in the pasteurizing plant to record the temperature to which the milk is heated and retained and to which the milk is cooled;
- records of the temperature on admission to the heat treatment establishment and immediately before pasteurization of any bulk milk which has, for the purposes of transportation, been heat treated in another heat treatment establishment;
- records of the results of plate count tests made on samples of bulk supplies of heat-treated milk intended for pasteurization;
- all microbiological results.

2.8 Pasteurized semi-skimmed and skimmed milk

For occupiers of dairy establishments who produce semi-skimmed and skimmed milk attention is drawn to the need to undertake operations within the requirements of current legislation (see Table 1 to Table 3).

2.9 Pasteurized milk-based drink or milk drink

For occupiers of dairy establishments who produce milk-based drink or milk drink attention is drawn to the need to be aware of the legal requirements (see Table 1 to Table 3).

2.10 Health and safety

2.10.1 Health and safety legislation

For pasteurization equipment and work practices attention is drawn to the Health and Safety at Work etc. Act 1974 and regulations made under that Act. These include six sets of regulations which implement European Directives. Other legislation includes the Factories Act 1961 and regulations made under that Act. Of particular relevance are regulations pertaining to management of health and safety; workplace health, safety and welfare; storage, handling and use of chemicals (COSHH); machinery; electricity and noise. Relevant legislation is listed in Annex A.

2.10.2 Risk assessment and control

The Management of Health and Safety at Work Regulations 1992 require employers to carry out assessments of risks to their employees and non-employees who may be affected by their work activity. Employers are then required to make arrangements for planning, organizing, controlling, monitoring and reviewing preventative and protective measures. Significant risks and arrangements required need to be recorded if more than five are employed. The record may form part of the company's health and safety policy statement which needs to include the organization and arrangements for implementing the policy. Competent persons with adequate, theoretical and practical knowledge should be appointed to assist the employer in this role.

Employers should assess the risks, list significant risks in order of priority, identify the standard of control required and prepare an action plan with reasonable timescales to achieve compliance. Arrangements should then be made to maintain standards.

Recent accident statistics in the food industry show that fatal accidents are frequently associated with transport and falls from height. In the milk industry major accidents are often associated with falls from height, slips, trips and falls on the level, exposure to chemicals and hot substances and machinery. These should therefore be addressed along with any other significant risks identified in particular workplaces.

Useful guidance is given in the free HSE leaflet IND (G) 132L Five Steps to Successful Health and Safety Management. BS 5304 deals with hazards arising from the use of machinery and methods for their elimination or reduction. This standard is still widely used but is gradually being superseded by European Standards. For example BS EN 294 is already available. The Dairy Trade Federation also publishes codes of practice on machinery safeguarding in relation to bottle fillers, de/re-craters, conveyors, stackers/de-stackers, cartoning machines, bottle washers, and crate handling machinery.

2.11 Advice

Persons in England and Wales who wish to engage in milk pasteurization on the individual farm should consult their local Council's Environmental Health Departments in England and Wales. Advice may be sought from ADAS, an executive agency of the Ministry of Agriculture, Fisheries and Food (MAFF).

In Northern Ireland advice should be sought from the Department of Agriculture for Northern Ireland, and in Scotland, from the Scottish Office, Agriculture and Fisheries Department, the Scottish Agricultural Colleges and the Local Authority District Council.

Table 3 — Summary of statutory requirements for milk pasteurization

The health rules for the production and placing on the market of pasteurized milk are laid down in EC Directive 92/46 of June 1992. Throughout the UK this Directive is implemented by the following regulations: The Dairy Products (Hygiene) Regulations 1994 The Dairy Products (Hygiene) (Scotland) Regulations 1994 The Dairy Products (Hygiene) Regulations (Northern Ireland) 1994		
Aspect	Description	Approvals/requirements
Registration, licensing, approvals and inspections	Production holding	MAFF (England and Wales) Food Authorities (Scotland) DANI (N. Ireland)
	Milk establishment Health mark Derogations Labelling Distribution	Food Authorities (England and Wales) Food Authorities (Scotland) DANI (N. Ireland)
Premises	Working and storage area	Hygienic construction and standards Supply of potable water Pest control programme Facilities for: cleaning and disinfection hand washing and personal hygiene storage of cleaning materials storage of packing materials staff changing rooms waste water disposal
Equipment	Food contact surfaces	Corrosion resistant, hygienic construction and standards.
	Pasteurizer (HTST)	Fitted with: automatic temperature controller flow diversion valve thermograph with hot milk, cold milk and events pen
	Pasteurizer (Batch)	Equipment as approved by the Food Authority
	Bottle washing	Mechanical in operation
	Filling of bottles and cartons ^a	Filled and sealed automatically
Hygiene conditions	Premises and equipment	Well maintained No cross contamination Cleaned at least daily Only suitable disinfectants used.
	Hazard analysis and critical control point (HACCP)	Critical control points: identified monitored checked recorded
	Staff	Wear protective clothing Provide medical certificates when recruited Undergo approved hygiene training
Markings on wholesale packages ^b	Health mark	Applied to all packages
	Other marks	To determine: nature of heat treatment date of heat treatment storage temperature minimum durability date

^a Derogation may apply for limited production.^b Special dispensations may apply for returnable glass milk bottles.

Section 3. Design, location and construction of dairy premises

3.1 General

Enforcing authorities in the United Kingdom may vary in their interpretation of legal regulations but the following proposals are given for guidance on good practice based on experience of milk processing on the individual farm and in the smaller dairy.

Attention is drawn to dairy legislation covering dairy premises. A well designed unit is needed to enable milk to be handled, processed or stored in such a manner as to prevent risk of contamination. In order to achieve this, separate units should be constructed, where practicable, to accommodate the following.

- a) Separate milking house or parlour.
- b) Separate raw milk storage area.
- c) Separate pasteurizing and milk packaging room with storage room for clean bottles or single service containers and milk churns.
- d) Separate bottle and milk churn washing room with storage area for dirty bottles and milk churns.
- e) Separate refrigerated pasteurized milk storage.

It is not always possible, particularly when utilizing existing buildings, to provide separate rooms for items b) and c). Where these operations have to take place in one room there is nevertheless a need to separate the work areas used and to give careful consideration to a suitable and orderly workflow in order to limit the potential for cross-contamination. A separate access to each defined work area is also recommended.

In the design of premises and allocation of space, consideration should be given to ancillaries without which it will not be possible to achieve efficiency in hygiene and operation. These include changing rooms, sanitary accommodation, refuse storage and space for services.

3.2 Situation of units at the producer processors' premises

3.2.1 Milking premises

The following should be observed.

- a) Milking premises should be sited so as not to present a risk of contamination and, in particular, milk should not be handled, processed or stored where it is liable to become contaminated or infected. No person should carry out any process of cooling, pasteurizing, bottling or packaging milk where the milk would be liable to contamination arising from any cowshed, byre, stable, manure heap or otherwise.

- b) Adequate hand washing facilities in the milking premises should be provided.

3.2.2 Pasteurizing and packaging area

The following should be observed.

- a) Where possible, this should be a separate room from that used to wash bottles and milk churns and for their storage prior to washing.
- b) The entrance to the pasteurizing and packaging area should be sited away from the same yard area in which cows are held before or after milking or where other animals are kept, and yard areas should fall away from any access points to the pasteurizing premises.
- c) Direct access to this area by milking personnel should be prevented.
- d) Filling of bottles, single-service containers or milk churns may take place in this area.
- e) Clean bottles, milk churns and single-service containers sufficient for the immediate needs may be held in this area prior to filling.
- f) Dirty bottles and milk churns (i.e. those awaiting cleansing) should not be stored in this area.
- g) Suitable handwashing and hand drying facilities should be provided in this area.

NOTE Non-hand operable taps (e.g. knee or foot operated) and disposable towels are preferred.

3.2.3 Bottle, milk churn and crate cleansing area

The following should be observed.

- a) Where possible, the area for cleansing bottles, milk churns and crates should be a room separate from the pasteurizing and packaging area.
- b) The area should be sited so as not to present a risk of contamination of bottles and milk churns after cleansing.
- c) Dirty bottles, milk churns, crates and other equipment awaiting washing may be stored in this area.
- d) If storage of dirty bottles, crates and milk churns is in an uncovered area then it should be adjacent to the wash room and not part of the yard where cows are held or other animals kept. A raised area is preferable.

3.2.4 Storage rooms

The following should be observed.

- a) After filling, bottles, milk churns and single-service containers should be kept in a separate refrigerated store which will keep the temperature of the milk at 5 °C or below.

b) The refrigerated store should be so constructed and sited as not to give rise to risk of contamination of the milk.

c) Adequate dry clean storage for single-service containers, bottle caps and filter cloths should be provided.

d) All clean bottles, milk churns and other containers should be stored in a clean place and protected from dust, dirt and contamination.

3.3 Situation of units in the small pasteurizing dairy

3.3.1 Milk reception and raw milk storage

The following should be observed.

- a) Where possible, a separate area for milk reception and raw milk storage should be provided.
- b) The area for milk reception and raw milk storage should be sited conveniently to a made-up roadway suitable for milk delivery by road tankers.
- c) The area should be secure and covered, with adequate ventilation to remove exhaust fumes from milk delivery vehicles.

3.3.2 Pasteurizing and packaging area

The following should be observed.

- a) Where possible, the pasteurizing and packaging areas should be a separate room from that used to wash bottles and milk churns and for their storage prior to washing.
- b) Filling of bottles, cartons or milk churns may be done in this area.
- c) Clean bottles, milk churns and single-service containers sufficient for the immediate needs may be held in this area prior to filling.
- d) Dirty bottles and milk churns (i.e. those awaiting cleansing) should not be stored in this area.
- e) A wash-hand basin complete with suitable drainage, hot and cold water, soap, towel and nail-brush should be provided in the packaging and pasteurizing area.

3.3.3 Bottle, milk churn and crate cleansing area

The following should be observed.

- a) Where possible, the area for cleansing bottles, milk churns and crates should be a room separate from the pasteurizing and packaging area.
- b) The cleansing area should be sited so as not to give rise to risk of contamination of bottles and milk churns after cleansing.

c) Dirty bottles, milk churns, crates and other equipment awaiting washing may be stored in this area.

d) If storage of dirty bottles, crates and milk churns is in an uncovered area, then it should be adjacent to the wash room. A raised area is preferable.

3.3.4 Storage rooms

The following should be observed.

- a) Pasteurized milk should be kept in bottles, milk churns, or single-service containers in a separate refrigerated store which will keep the temperature of the milk at 5 °C or below.
- b) The refrigerated store should be so constructed and sited as not to give rise to risk of contamination of the milk.
- c) Adequate dry, clean storage should be provided for single-service containers, bottle caps and filter cloths before use.
- d) All clean bottles, milk churns and other containers should be stored in a clean place and protected from dust, dirt and contamination.

3.4 General constructional recommendations

3.4.1 Floors

Floor finishes should be non-slip, heat-resistant, non-absorbent, robust, easily cleaned and resistant to acids, alkalis and hot substances.

A well laid quarry tile floor will meet most of these recommendations. Blue engineering bricks on edge give a very hard-wearing floor finish. Similarly a properly laid granolithic concrete floor will be satisfactory.

Floors should be provided with a minimum fall of 1 in 60 to a properly trapped drainage system. A coving to the walls should be provided during construction.

3.4.2 Walls

Walls should be finished with a smooth, impervious and washable surface, free from any ornamental or other unnecessary projection and present a clean and hygienic appearance. Where possible, service pipes and conduits should be sunk into walls or fixed well clear of wall surfaces to facilitate cleaning.

Walls should be well insulated, preferably including a vapour barrier to avoid condensation and deter infestation.

3.4.3 Ceilings

Ceilings or roofings should be non-absorbent, finished to a smooth surface and capable of easy cleaning.

3.4.4 Lighting

Premises should have the best possible lighting without glare. This should be in the form of ceiling-mounted fluorescent lights giving an illumination of at least 300 lx, which should be increased to 500 lx at specific critical areas, e.g. filling and inspection. The fittings should be of plastics or of glass, covered with a plastics shield so as to prevent fragments of glass entering milk and milk products.

3.4.5 Ventilation

The ventilation system should be designed with the following in mind.

- a) The air should be maintained at a temperature and humidity which will prevent condensation as far as practicable and assist in keeping milk rooms cool in summer.
- b) Dust, dirt, insects and vermin should be excluded, particularly from clean areas.

The ventilation requirements will depend on the purpose for which the room is used but in any room some degree of mechanical ventilation is desirable. Particular attention should be given to areas where steam occurs.

Intake points and the direction of the air flow should be planned to avoid risk of contamination of milk by dust, external fumes, etc.

Canopies, if used, should be of the open-tent type and preferably constructed of polished alloy.

Ventilation ducts inside premises should be fitted flush with the walls or ceiling or positioned to allow effective cleaning. Duct inlets should be proofed against insects and not sited near dusty places.

3.4.6 Joinery, doors and windows

All internal joinery work should be of simple design and finished to a high standard of workmanship. A high gloss surface is required. Unplasticized polyvinyl chloride (UPVC) surfaces are preferred for doors, windows, etc.

Windows should preferably be of the hopper type with inward opening lights. Ideally all windows should have fly screens fitted to the outside which should be removable for cleaning purposes and the sills should be sloping.

All doors should be flush finished on the interior side, capable of easy cleaning and should be protected on both sides by non-corroding metal kick plates to prevent damage which may provide access for rodents.

3.4.7 Services

Services should be installed using suitable piping, lagging and conduits to facilitate cleaning and maintenance. Service lines should be positioned to minimize potential contamination to the product and minimize hazards in the workplace.

3.4.8 Water supply

Considerable quantities of hot and cold water are needed. If cold water storage is required the tanks should be kept covered and protected from extremes in temperature and from vermin. An overflow should be piped to discharge outside the building and in such a manner that any discharge is readily seen.

The water used in the pasteurizing premises should be clean water (see 1.3.7). The water should be microbiologically tested at least twice a year and especially following cleaning and disinfection of water storage tanks.

In cases where the total water hardness exceeds 150 p.p.m. (CaCO_3) (see BS 2690-109:1984) an ion exchange water softener is recommended for all water where heat treatment, cleaning or rinsing is involved.

Storage tanks of adequate capacity should be provided to ensure at least one day's supply in case of supply failure. The tanks and contents should be inspected at frequent intervals and emptied, cleaned and disinfected as necessary and at least once per year.

Section 4. Components and functions of equipment used for milk pasteurization on farms and in small dairies

4.1 Holder (batch) pasteurization

4.1.1 General

The holder (batch) method for the pasteurization of milk is permitted. It is a practical alternative to continuous flow HTST pasteurization only where small quantities of milk, e.g. up to 1 000 l per day, are being processed. There may be circumstances in addition to those of scale where this process has advantages.

The process consists of heating milk to between 62.8 °C and 65.6 °C and retaining it between these temperatures for at least 30 min.

4.1.2 Basic components of a batch pasteurizer for milk

4.1.2.1 A vessel of stainless steel is needed within which the milk is heated to a temperature within the legally permitted range, maintained at that temperature as required and subsequently cooled.

The vessel should incorporate an insulated outer jacket through which the necessary heating and cooling media can flow.

The heating medium may be either steam at atmospheric or low pressure or water heated by steam, electric or gas heating devices. The cooling medium may be either mains water, chilled water or a mixture.

The heating and cooling media can be applied to the outer surface of the vessel either by being passed continuously through the jacket or by spraying on to it. Additional cooling after treatment may be effected by passing the treated milk through a plate heat exchanger.

4.1.2.2 An agitator, usually fitted vertically and which rotates continuously during pasteurization, is necessary to give rapid and uniform heating of the milk. To avoid butter fat damage, slow speed large diameter paddles are used.

4.1.2.3 Thermometers should be fitted to indicate the temperature of the heating medium in the jacket and the milk in the vessel.

4.1.2.4 A recording thermometer is recommended for evidence of correct pasteurization and associated cooling temperatures.

4.1.2.5 A temperature control device is needed which automatically regulates the heating of the milk to pasteurization temperatures and the subsequent retention at these temperatures for the holding period and cooling. This device is essential for legal reasons and should be fitted in such a way as to ensure consistent safe operations.

4.1.3 Sequence of operations

Milk is admitted to the disinfected pasteurizer vessel and heated by hot water in the jacket. The milk is thoroughly but slowly mixed by the agitator during heating and subsequent operations.

The temperature of the milk is held between 62.8 °C and 65.6 °C for a minimum of 30 min before cooling is commenced either in the vessel or externally.

The pasteurized milk should be cooled to a temperature not higher than 5 °C.

4.2 HTST (continuous) pasteurization

4.2.1 General

Heating and cooling duties according to the legal regulations for pasteurized milk are carried out continuously in plate heat exchangers.

Groups of high grade stainless steel plates resistant to the corrosive effects of coolants and chemical disinfecting agents are clamped vertically in a frame between a fixed head and a movable follower which allows the plates to be slackened or removed for inspection, etc.

The plates are separated by gaskets of synthetic rubber which are securely fixed in grooves. The gaskets form seals at the outer edges of the plates and around two of the four ports in each plate so that the milk and the heating or cooling water are distributed across opposite sides of the plate. The plates are grouped in sections for heating, cooling and regeneration (heat recovery where heat is transferred from the hot pasteurized milk to the cold raw milk). Connector grids provide inlet and outer ports for the various liquids and separate one section from the next.

Gaskets are designed to give a double seal between the liquid streams and make intermixing impossible between milk and water, or between pasteurized and unpasteurized milk.

The interspace, or gap, between seals is vented to atmosphere so that in the unlikely event of gasket failure, leakage is to the outside and a visual indication of the fault is produced.

4.2.2 Components of HTST plants

4.2.2.1 The normal components of the milk pasteurization installation are shown in Figure 1 and comprise the items listed in 4.2.2.2 to 4.2.2.9.

4.2.2.2 The plate heat exchanger (see Figure 2) comprises regenerative, heating and cooling sections, of a capacity chosen to suit the daily processing requirements. Plate heat exchangers for the pasteurization of milk vary in capacity from around 225 l/h to around 50 000 l/h.

4.2.2.3 A balance tank (see Figure 3), provides a constant head of milk to feed the milk pump, and receives any milk rejected during diversion. It can also be used as the header tank for the circulation of solutions during cleaning in place. The level is maintained by a float-operated valve which provides shut-off against the milk supply. All interior and exterior surfaces should be polished and crevice-free.

NOTE A balance tank may not always be fitted to certain models of small heat exchangers.

4.2.2.4 A centrifugal milk pump should be constructed of stainless steel and to a design which will ensure sanitary conditions. The pump passes milk, cleaning liquids, disinfecting hot water, or rinse waters through the system as appropriate.

4.2.2.5 A flow control unit (see Figure 4) regulates the flow of milk to the plate heat exchanger, irrespective of fluctuations in pressure or head on either suction or delivery side. It thus performs the essential function, where a centrifugal pump is used, of ensuring a constant rate of milk and eliminating fluctuations which would cause variations in holding time and possibly in temperature.

Milk enters at the inlet, passes through a strainer to the shaped ports in the shell and continues upwards past the control disc. If the flow increases, the disc is lifted and the plunger rises to reduce the area of the ports and so restrict the flow.

A specified rate of flow can thus be maintained with any particular control disc. Should a different rate be required the control plunger, with its spindle and disc, can be removed and a different one substituted.

In some simple small installations a preset restrictor or orifice plate may be used to control the amount of milk passing through the heat exchanger. In these circumstances, especially if no balance tank is fitted to reduce the variation in flow rate, there is a need to calculate the throughput in relation to the designed maximum flow rate.

Phosphatase test failures of skimmed milk but not of whole milk can result if preheated milk is passed through a cream separator and back to the pasteurizer in the absence of adequate flow control mechanism. While operating under these conditions the flow controller should be checked to see that it is in position and a test of the holding time and temperature should be carried out.

4.2.2.6 A hot water set (see Figure 5 a) and Figure 5 b) is heated and circulates the water through the plate heat exchanger to raise the milk to pasteurization temperature.

The water circulating pump is normally located immediately below on the floor. This compact and simple arrangement keeps pipelines to a minimum, thus reducing heat loss. The small amount of water in circulation ensures a rapid response to changes in temperature.

Steam injection is controlled by a diaphragm valve operated via a temperature controller in the panel. This is actuated by a resistance thermometer in the mixing vessel. Variations in the water temperature produce an immediate response in the diaphragm valve, and consequently in the amount of steam injected. The water temperature is thus maintained within very narrow limits.

The steam line is provided with the necessary reducing and relief valves, and gauges.

Electricity may be used instead of steam to heat the water required for pasteurization. In this case immersion heaters, adequate for the pasteurization rate, are positioned in the tank of the hot water set.

In one design of plant the closed circuit for electrically-heated hot water circulation includes the cell in which the milk is held for a minimum of 15 s at pasteurization temperature.

Vacuum steam heating is an alternative to hot water as a means of heating the milk.

4.2.2.7 A filter or clarifier is supplied either as a free-standing or plant-mounted component depending upon the type of installation.

Where there are two filter chambers, cloths may be exchanged without interrupting the processing run. Each chamber contains a tube-shaped filter cloth supported on a double cylinder of perforated steel which is easily accessible.

4.2.2.8 A flow diversion valve (FDV) (see Figure 6 a) and Figure 6 b) and thermograph (see Figure 7) are needed. The flow diversion valve assembly and the thermograph together should provide a complete recording and safeguarding system. The thermograph, situated in the control panel, gives an automatic and permanent record of every operation of the plant from sterilization at start-up to final detergent circulation. It records not only temperatures but also every interruption of the normal run such as a diversion.

The thermograph is operated by a resistance thermometer located in the milk stream after the holder. The flow diversion valve assembly is automatically actuated if the temperature of milk falls below the preset level. Response is virtually instantaneous and guarantees that no unpasteurized milk goes forward.

For cleaning purposes, and during start-up or shut-down, the plant is fitted with a manual override to avoid energizing the flow diversion valve. It is most important, however, that the machine is in automatic mode with the safeguards on while milk is being pasteurized. Regulations stipulate that thermographs are fitted with a safeguard "event" pen which records the position of the "auto/manual" switch throughout the operating cycle of the plant.

Consisting of either a pair of standard on/off operated valves, or, for specified plants, a single changeover valve, the flow diversion valve assembly uses direct air or electrically operated solenoid for forward flow and spring pressure for diversion, so that any failure of air or electricity moves the valve into the diverted position. Diverted milk is bypassed to the balance tank for recirculation until the correct pasteurization temperature is restored.

A green light on the control panel indicates that all is in order, while on a diversion a red light shows and an alarm sounds.

4.2.2.9 A holding time device is a means of ensuring that the legal minimum time of exposure to the pasteurization temperature is achieved. Holding is most commonly achieved by means of external holding tubes which ensure that the milk will be held at pasteurization temperature for a minimum of 15 s before passing to the first stage of cooling.

4.2.3 Sequence of operations

Raw milk flows from the storage or receiving tank to the balance tank in which a constant level is maintained by a float valve.

The milk is pumped at the rate regulated by the flow controller (or positive pump) to the regenerative section of the plate heat exchanger. In this section the raw milk is pre-heated by the pasteurized milk leaving the holder section, the returning pasteurized milk being itself partly cooled. The pre-heated milk passes to the filter then to the heating section where the temperature is raised to just above the legal minimum temperature by the circulation of hot water. Pasteurizing temperature and diversion are recorded continuously during operation.

The milk at the pasteurization temperature flows through the holding tubes and should the flow diversion assembly and temperature controller sense that the milk leaving the holding section has fallen below the minimum pasteurization temperature it is automatically diverted back to the balance tank.

After the holding period of not less than 15 s the pasteurized milk returns to the plate heat exchanger for cooling by regeneration, cold water, and finally by chilled water or other coolant. Cooling by regeneration results in the milk being reduced in temperature to around 9 °C to 12 °C depending on the type of plant and other factors including the temperature of the raw milk.

The additional cooling should reduce the temperature of the pasteurized milk to between 3.5 °C and 5 °C.

The temperature of the pasteurized milk is recorded before it passes to the storage tank and/or packaging equipment.

4.3 Continuous flow shell and tube heat exchangers

This type of heat exchanger consists of two concentric tubes in which the liquid to be heated or cooled flows through the inner tube and the heating/cooling medium flows continuously in the opposite direction through the annular space between the inner and outer tubes.

In developments of this type of heat exchanger, infra-red radiation has been used commercially for small-scale pasteurization. The infra-red radiation is generated by electrically-heated elements.

In one type of plant the elements are coiled within a quartz tube with the milk flowing through the annulus between the tubes, while in another commercial type of plant the elements are coiled round the quartz tube through which the milk flows.

In plants of this type the cold milk is pumped to the regeneration section where it is heated by the exchange of heat from the hot milk passing in the opposite direction. The partly warmed milk then passes across the infra-red radiation elements where in a few seconds it reaches the pasteurization temperature of 72 °C and is held at that temperature for the minimum holding period of 15 s in a series of holding tubes, before preliminary cooling in the regeneration section and final cooling by chilled water in the final bank of tubes. Two solenoid-operated valves are fitted, one at the end of the holding section, and the other at the diversion point. Both operate if the pasteurization temperature is not obtained; one opens the diversion pipe taking the under-heated milk for recirculation. The second solenoid-operated valve shuts off the flow of the milk to the regenerative cooling section.

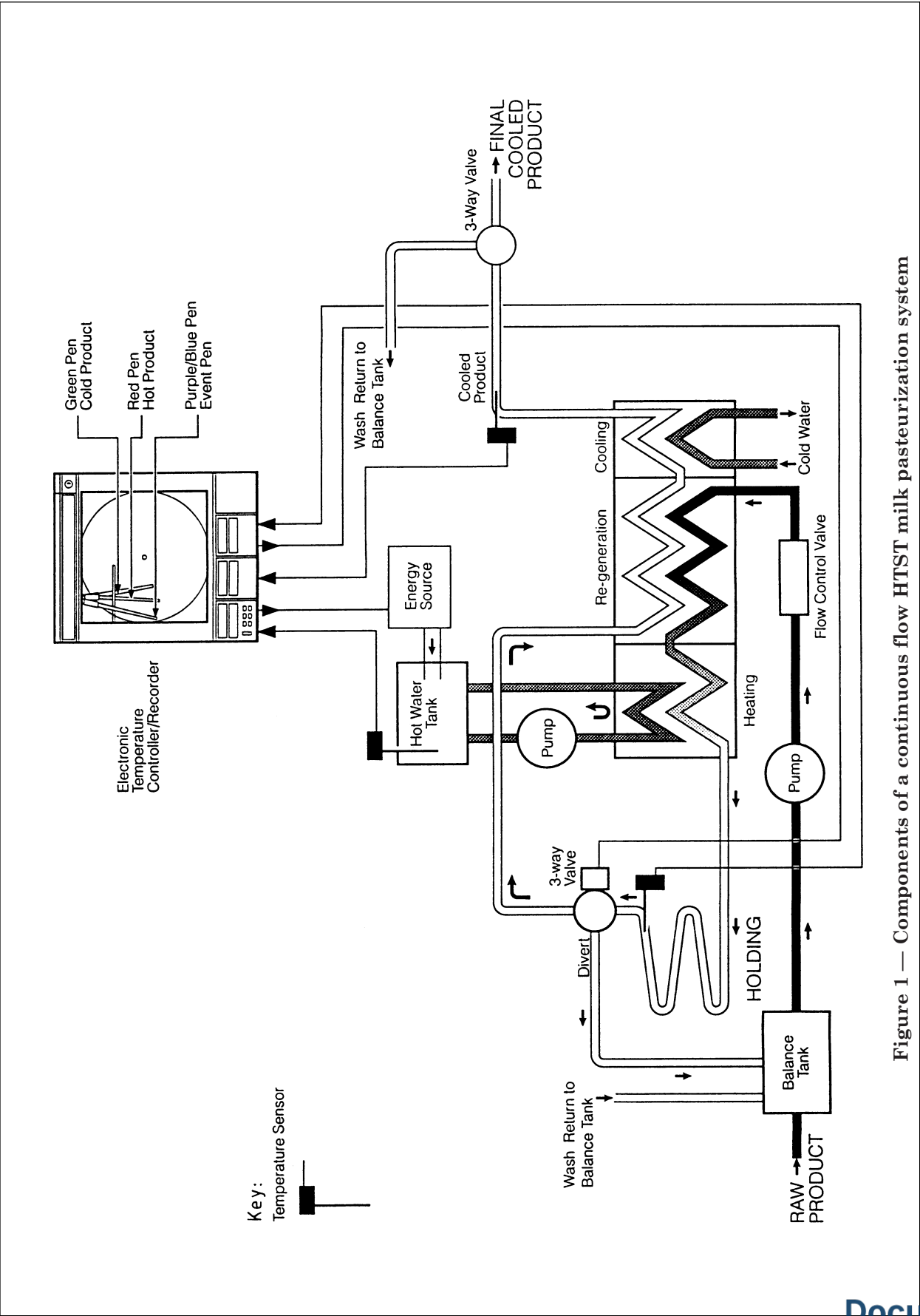


Figure 1 — Components of a continuous flow HTST milk pasteurization system

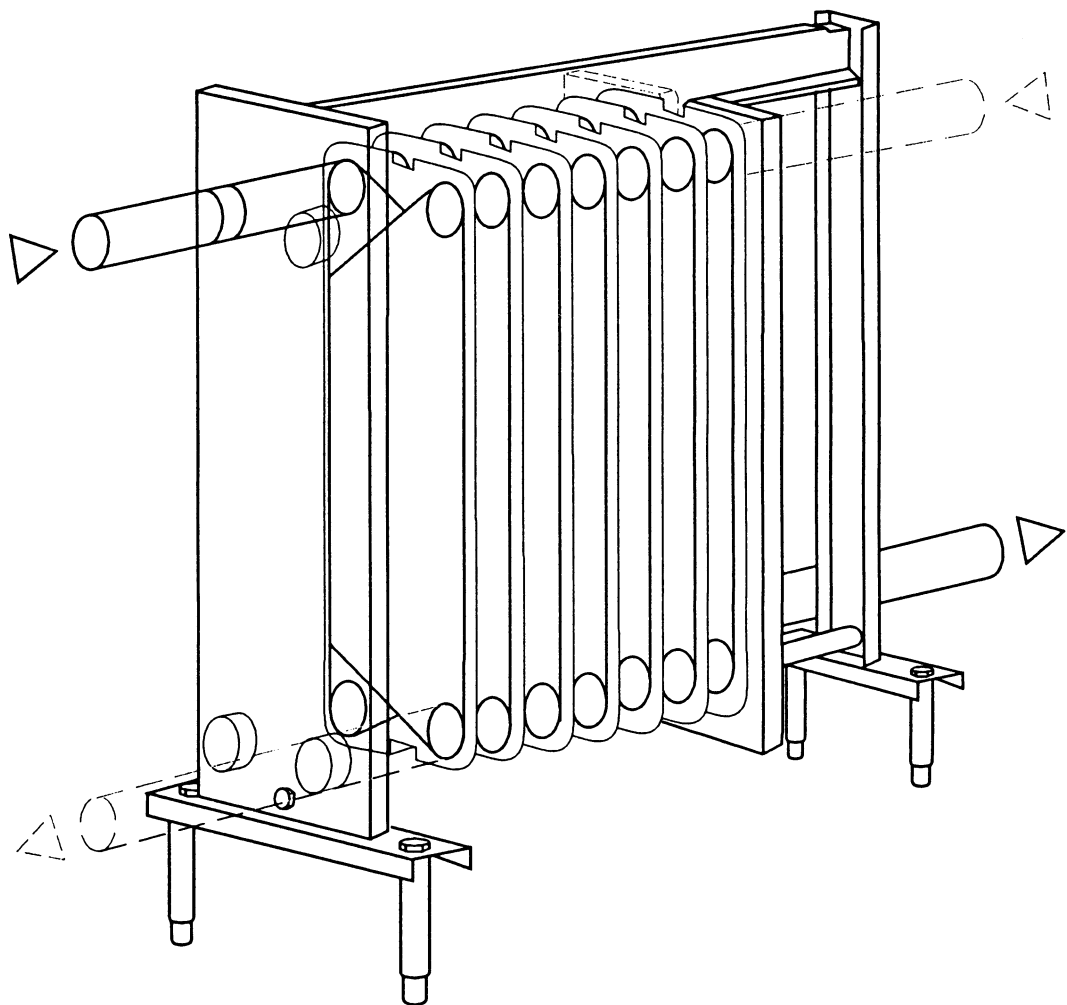
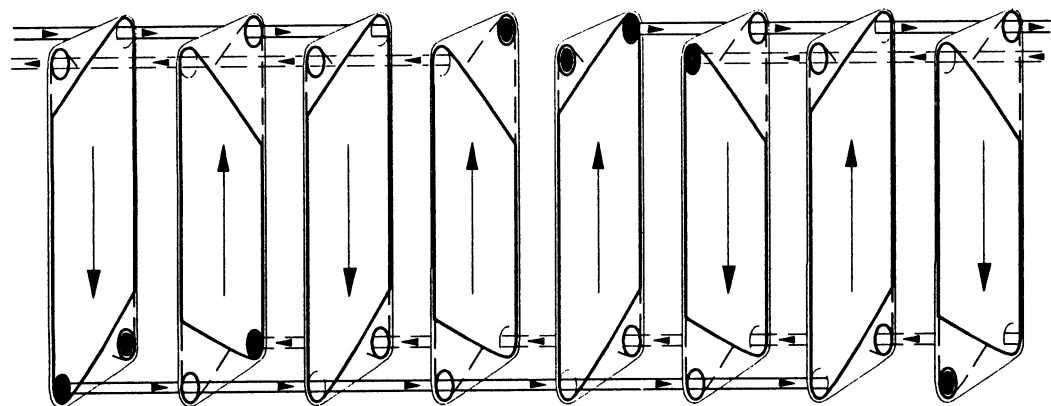
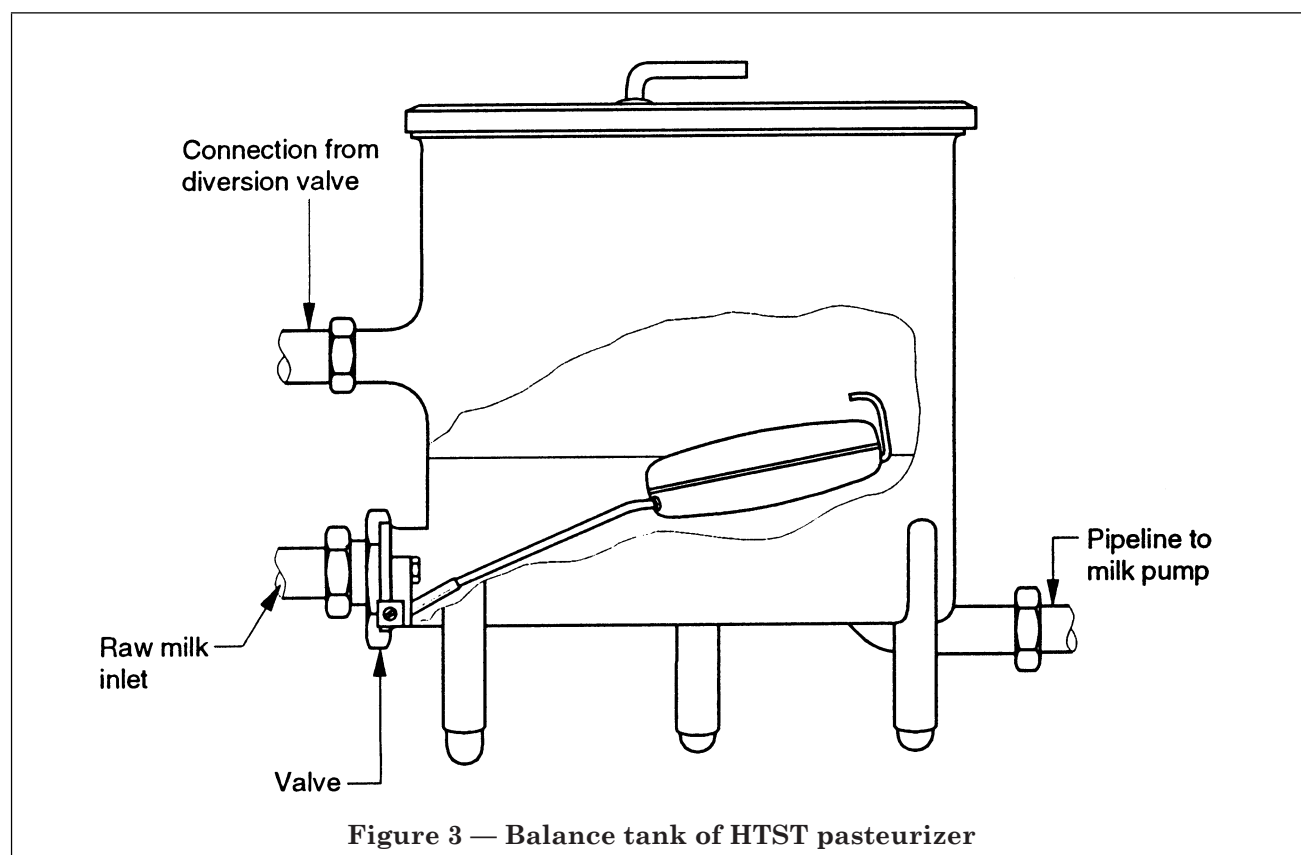


Figure 2 — General arrangement of a plate heat exchanger



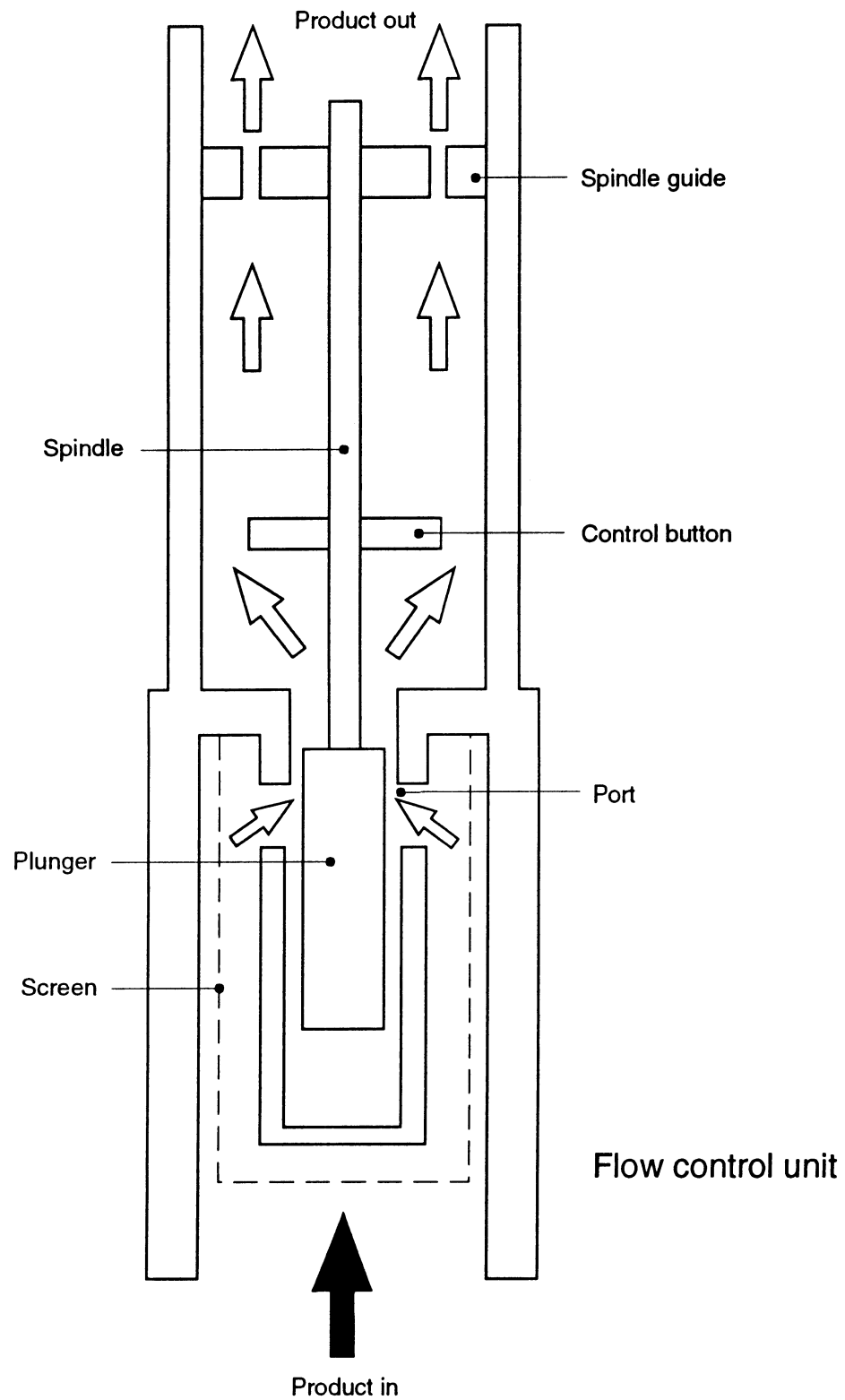
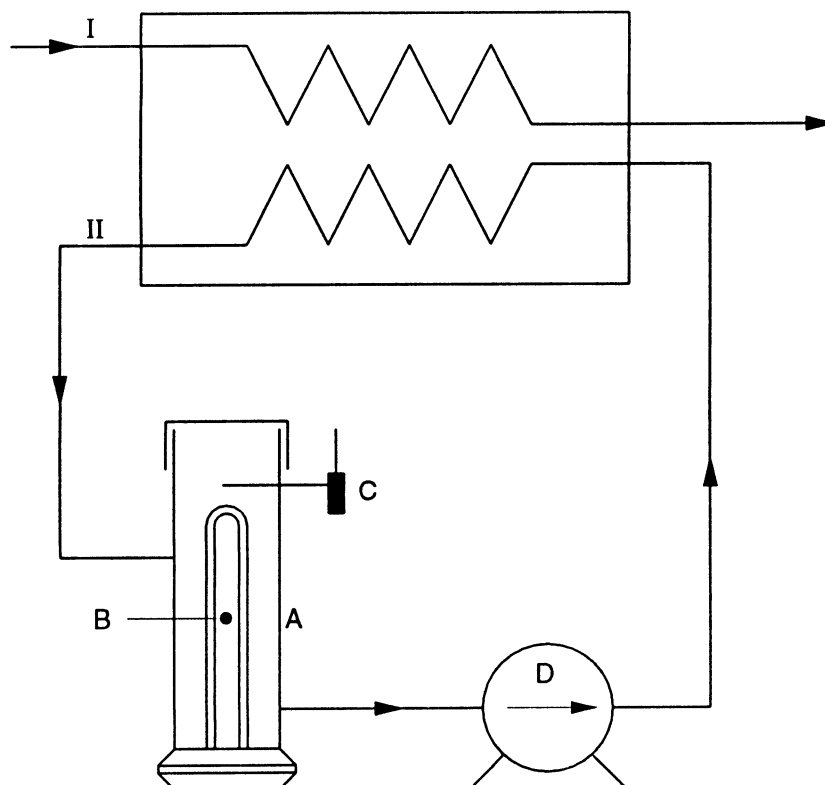


Figure 4 — Example of a HTST pasteurizer flow control unit

**Key**

- A Water heater
- B Electrical element
- C Temperature sensor
- D Water pump
- I Milk flow
- II Hot water circuit

Figure 5 — Components of a hot water set a) electrically heated