



# Heat Treatment

Code of Practice

Amendment 0

November 2009

## Table of Contents

<b>Heat Treatment .....</b>	<b>1</b>
Disclaimer .....	7
Review of Code of Practice.....	7
<b>1 Introduction .....</b>	<b>8</b>
1.1 Scope & Purpose.....	8
1.2 Intent.....	9
1.3 Definitions .....	10
<b>2 Heat Treatment to achieve Pasteurisation .....</b>	<b>15</b>
2.1 Purpose of Pasteurisation .....	15
2.2 Non-conforming Dairy Material.....	15
2.3 Required Outcomes for Pasteurisation.....	15
2.4 Heat Treatments .....	21
<b>3 Design and Fabrication of Pasteurisation Equipment.....</b>	<b>26</b>
3.1 General Design and Fabrication Requirements .....	26
3.2 Acceptable Cross Connections .....	26
3.3 Materials .....	29
3.4 Cleaning Systems.....	30
<b>4 Computer Control Systems .....</b>	<b>32</b>
4.1 Design Requirements .....	32
4.2 Scan Time.....	33
4.3 Security.....	34
4.4 External Communication.....	37
<b>5 Data Collection and Recording System.....</b>	<b>39</b>
5.1 Purpose .....	39
5.2 Data Sensing .....	39
5.3 Data Indicating Systems.....	40
5.4 Data Recording Systems.....	42
<b>6 Critical Parameter Security.....</b>	<b>47</b>
6.1 General .....	47
6.2 Alterations to Critical Parameters.....	47
<b>7 Testing and Calibration.....</b>	<b>48</b>
7.1 General Requirements.....	48
7.2 Design Requirements for Testing.....	48

7.3	Responsibilities and Reporting .....	51
7.4	Monitoring .....	51
7.5	Pasteuriser Evaluation and Verification .....	60
<b>8</b>	<b>General Design of Batch Pasteurisers .....</b>	<b>61</b>
8.1	The Batch Pasteurisation Process .....	61
8.2	Heat Treatment to Achieve Pasteurisation .....	61
8.3	General Requirements for Batch Pasteurisers .....	62
8.4	Height and Placement of the Vat .....	63
8.5	Heating Jacket .....	63
8.6	Agitation .....	63
8.7	Air Space Heating .....	64
8.8	Covers .....	65
8.9	Fittings .....	66
8.10	External Heating .....	66
8.11	Filter Maintenance .....	67
<b>9</b>	<b>Prevention of Mixing of Raw and Pasteurised Product .....</b>	<b>68</b>
9.1	Requirements .....	68
9.2	Valve Design .....	69
9.3	Inlet Design .....	69
9.4	Outlet Design .....	70
<b>10</b>	<b>Control Systems .....</b>	<b>72</b>
10.1	Requirements for Pasteurisation .....	72
10.2	Temperature Monitoring System .....	72
10.3	Differential Pressure Monitoring .....	74
10.4	Data Recording System .....	74
10.5	Calibration .....	76
<b>11</b>	<b>HTST Pasteurising Systems .....</b>	<b>77</b>
11.1	Components of HTST Pasteurising Systems .....	77
11.2	Heat Treatment to Achieve Pasteurisation .....	77
<b>12</b>	<b>Raw Product Balance Tank .....</b>	<b>78</b>
12.1	Purpose .....	78
12.2	Requirements .....	78
<b>13</b>	<b>Raw Product Pump .....</b>	<b>80</b>
13.1	Purpose .....	80
13.2	Requirements .....	80
<b>14</b>	<b>Heat Exchanger .....</b>	<b>81</b>
14.1	Purpose .....	81
14.2	Design .....	81

---

14.3	Heating and Cooling Mechanisms.....	81
14.4	Leak Escape.....	82
14.5	Operating Differential Pressures for Non-Potable Systems.....	82
14.6	Inspection Requirements.....	82
<b>15</b>	<b>Intermediate Balance Tank.....</b>	<b>83</b>
15.1	Purpose.....	83
15.2	Requirements.....	83
<b>16</b>	<b>Filter or Centrifuge.....</b>	<b>84</b>
16.1	General.....	84
16.2	Equivalent Pore Size for Centrifuges.....	84
16.3	Filter Maintenance.....	84
<b>17</b>	<b>Timing Pumps and Other Flow Rate Control Systems.....</b>	<b>86</b>
17.1	General.....	86
17.2	Location.....	87
17.3	Types of Pump.....	87
17.4	Flow Rate Monitor.....	88
17.5	Flow Rate Accuracy.....	88
17.6	Flow Rate Confirmation.....	88
17.7	Protection Systems for High Flow Rates.....	88
17.8	Return to Forward Flow Position.....	89
<b>18</b>	<b>Holding Tube.....</b>	<b>90</b>
18.1	Purpose.....	90
18.2	Design Requirements.....	90
18.3	Fittings.....	91
<b>19</b>	<b>Diversion System.....</b>	<b>93</b>
19.1	General.....	93
19.2	Flow Diversion Device.....	93
19.3	Temperature Diversion Control.....	98
19.4	Monitoring and Recording System.....	101
19.5	Temperature Indicators.....	102
19.6	Testing and Calibration.....	103
<b>20</b>	<b>Differential Pressure Control System.....</b>	<b>104</b>
20.1	General.....	104
20.2	Differential Pressure Control.....	104
20.3	Differential Pressure Recycle Device.....	106
20.4	Differential Pressure Data Recording.....	108
20.5	Prevention of Siphoning.....	109
20.6	Testing and Calibration.....	109

<b>21</b>	<b>Data Recording System .....</b>	<b>110</b>
21.1	Purpose .....	110
21.2	Data to be Recorded.....	110
<b>22</b>	<b>General Requirements for Vacuum Steam Pasteurisers .....</b>	<b>111</b>
22.1	Scope & Background .....	111
22.2	Vacuum Steam Pasteurisation .....	111
22.3	Heat Treatment delivered by Vacuum Steam Pasteurisation.....	112
<b>23</b>	<b>General Design Parameters .....</b>	<b>113</b>
23.1	Components of a Vacuum Steam Pasteurisation System.....	113
23.2	Design and Fabrication.....	113
23.3	Raw Product Balance Tank .....	114
23.4	Intermediate Product Balance Tank .....	114
23.5	Flow Rate Control System.....	114
23.6	Heat Exchanger .....	114
23.7	Filter or Centrifuge .....	115
23.8	Vapour-Liquid Separation Vessel and Condenser .....	115
23.9	Holding Section.....	116
23.10	Product Outlet Pump .....	118
<b>24</b>	<b>Control Systems .....</b>	<b>119</b>
24.1	Temperature Diversion System .....	119
24.2	Differential Pressure Control System .....	119
24.3	Data Recording System.....	119
24.4	Computer Control Systems.....	119
24.5	Testing and Calibration.....	120
24.6	Critical Parameter Security .....	120
<b>25</b>	<b>General Requirements for Evaporators and Concentrate Pasteurisers .....</b>	<b>121</b>
25.1	Scope and Background .....	121
25.2	Heat Treatment to Achieve Pasteurisation .....	121
<b>26</b>	<b>General Design Parameters .....</b>	<b>123</b>
26.1	Components of an Evaporator Preheat Pasteurisation System .....	123
26.2	Components of a Concentrate Pasteurisation System.....	125
26.3	Design and Fabrication.....	126
26.4	Product Balance Tank .....	126
26.5	Product Pump .....	126
26.6	Flow Rate Control Systems (Evaporators and Concentrate Heaters).....	127
26.7	Preheaters Internal in the Evaporator.....	127
26.8	External Flash Vessel Preheaters Prior to the First Effect of the Evaporator .....	128
26.9	Cross Connections .....	129

---

26.10	Holding Section for Preheat and Concentrate Pasteurisers.....	129
26.11	Flow Diversion or Stopping System.....	130
26.12	CIP after Contamination with Unpasteurised Product.....	132
26.13	Filter or Centrifuge.....	132
26.14	Vapour-Liquid Separation Vessel and Condenser within Evaporator.....	132
<b>27</b>	<b>Control Systems.....</b>	<b>134</b>
27.1	Diversion System.....	134
27.2	Cross Contamination Control System.....	134
27.3	Data Recording System.....	134
27.4	Computer Control Systems.....	134
27.5	Testing and Calibration.....	135
27.6	Critical Parameter Security.....	135
<b>28</b>	<b>Appendix 1: Pasteuriser Logging System Event Report.....</b>	<b>136</b>

---

## Disclaimer

### *IMPORTANT DISCLAIMER*

Every effort has been made to ensure the information in this report is accurate.

NZFSA does not accept any responsibility or liability whatsoever for any error of fact, omission, interpretation or opinion that may be present, however it may have occurred.

### *Website*

A copy of this document can be found at: <http://www.nzfsa.govt.nz>

## Review of Code of Practice

This code of practice will be reviewed, as necessary, by the New Zealand Food Safety Authority. Suggestions for alterations, deletions or additions to this code of practice, should be sent, together with reasons for the change, any relevant data and contact details of the person making the suggestion, to:

Assistant Director (Production, Processing and Sale)

Standards Group

New Zealand Food Safety Authority

P O Box 2835

Wellington

Telephone:04 894 2500

Facsimile:04 894 2643

---

# 1 Introduction

## 1.1 Scope & Purpose

This document sets requirements for the design, construction and operation of equipment, including control and recording instrumentation, used for heat treatment of milk and other liquid dairy material.

The aim of pasteurisation is to avoid public health hazards arising from pathogenic micro-organisms associated with milk and to reduce spoilage organisms, along with ensuring minimal chemical, physical and sensory changes in the product.

There are two distinct applications for which this code may be used.

The primary application is where this code is referenced from a Risk Management Programme (RMP) registered by NZFSA. The purpose of this application is mandatory compliance with regulatory requirements. Pasteurisation equipment that is designed, built and operated to this code will partly satisfy NZFSA requirements for dairy heat treatment. Full compliance with NZFSA requirements for dairy heat treatment also requires:

- The pasteurisation equipment must have a current evaluation.
- The manufacturer must be able to demonstrate compliance appropriate to the performance-based verification category to which they have been assigned by NZFSA. Additional procedures (such as the operation and maintenance of the pasteurisation equipment, training, and corrective action) must be documented in, or referenced from, a RMP, or a Heat Treatment Plan referenced from the RMP, for the premises.
- The pasteurisation equipment must be operated in accordance with that NZFSA registered RMP and Heat Treatment Plan.

In this application the code may or may not deliver compliance with specific requirements for importing countries. Dairy processors are responsible for ensuring compliance with the requirements for specific markets

The secondary application is where this code is used as a voluntary technical manual for the design, construction and operation of dairy pasteurisation equipment. In this application the code is not used to fulfil any mandatory regulatory requirements and is not linked to any RMP. In this non-mandatory application internal audits may be applied to determine compliance with the requirements of the code.



The scope of this code includes:

the high temperature short-time (HTST) treatment of liquid milk in the following pasteurisers:

- heat exchanger type pasteurisation (continuous);
- vacuum steam pasteurisation (continuous);
- evaporators and concentrate heater pasteurisation (continuous); and also the low temperature long-time (LTLT) heat treatment of liquid milk in batch pasteurisers.

This code does not cover:

- thermisation for cheese making
- ultra high temperature (UHT) treatment
- stove top heat treatment.

This code does not prescribe hygienic design requirements for pasteurising equipment. A design and fabrication standard shall be nominated against which the work can be audited. The standard nominated shall be acceptable to and approved by NZFSA. Requirements for cleaning can be found in NZS 2541: 1998, "Guide to the cleaning-in-place of dairy factory equipment".

## 1.2 Intent

Where this code is used for the primary application of regulatory compliance:

Shall, express a requirement which is mandatory;

Should, express a recommended provision which when followed may improve the design or operation of the pasteurisation equipment.

It is possible that mandatory requirements may be able to be achieved in individual plants by means other than those described in this code. In that case validation of the alternative procedure and ongoing verification must be performed to demonstrate equivalence. Such "alternative criteria" must be formally approved by NZFSA as part of the approved RMP.

Where this code is used for the secondary application as a technical manual:

Shall, express a requirement which is essential for full compliance with this code;

Should, express a recommended provision which when followed may improve the design or operation of the pasteurisation equipment.

### 1.3 Definitions

**Air-gap plate heat exchanger** A plate heat exchanger that utilises the “two plate” “air gap” system, where there is by design a leakage path to atmosphere between the two plates. The “air gap” and leakage path act as a safety zone in case of “through plate” leakage due to corrosion or wear. Where “through plate” leakage occurs, the two liquids will not be mixed, but will be discharged between the two plate walls to the atmosphere.

**Animal material** Any live or dead animal, or any tissue or other material taken or derived from an animal.

**Chilling** A reduction in temperature using non-potable water which may contain acceptable food-grade additives.

**CIP** Clean-in-place, i.e. cleaning by circulation of cleaning solutions through equipment without dismantling.

**Clean** Free of soil, food residue, dirt, grease, cleaning or sanitising agents or other objectionable matter.

**Computer control system** Any system used to control a process which is microprocessor based. This term includes programmable logic controllers (PLCs), distributed control systems, personal computers and electronic controllers.

**Continuous-flow system** A system in which product passes in a continuous flow through heating and cooling equipment in order to receive the required heat treatment. Such systems usually incorporate one or more regeneration sections in which there is transfer of heat between the hot pasteurised product and incoming raw product.

**Cooling water** Potable or non-potable water used for reducing the temperature of product. A cooling section in a heat exchanger is a section which uses cooling water.

**Cross connection** A piped connection between a pasteurised product line and an unpasteurised product line.

**Dairy material** (formerly known as dairy produce)

- a. means animal material that is---
  - i. milk extracted from a milking animal; and
  - ii. any material derived or processed from milk extracted from a milking animal, up until delivery of the material at the place of sale for consumption or for end use for purposes other than consumption, or its export; and

- b. includes dairy product that, having been purchased or imported, is further processed.

**Dairy processing** (for the purposes of this code) means all processing activities in relation to dairy material; and includes---

- a. processing of dairy material, including heat treatment, cooling, separation, concentration, filtering, blending, and extraction of milk components.
- b. the addition of other material ( including food, ingredients, additives, or processing aids as defined in the Food Standards Code), or other dairy material, to a dairy material.
- c. the manufacture of products containing dairy material, including dairy products.

**Dairy processor** means a person who, for reward (other than as an employee) or for purposes of trade, carries out dairy processing, and includes the operator of any premises where dairy material is processed or manufactured or stored.

**Dairy product**

- a. means animal product that, having originally been dairy material,---
  - i. has been delivered to the place of sale for consumption, or for end use for purposes other than consumption; or
  - ii. has left New Zealand's territorial waters in the course of its export; and
- b. includes dairy produce within the meaning of the Dairy Industry Act 1952 (as in force before its repeal by section 75 of the Animal Products (Ancillary and Transitional Provisions) Act 1999).

**Equipment** All apparatus, containers, conveyances, machinery, piping, pumps, utensils, vehicles, and other things used in the transport, reception, testing, grading, manufacture or storage of product.

**Evaluation** means the process of independent external assessment by a recognised person or recognised agency of the validity of a risk management programme for the purposes of providing an independent evaluation report as required under section 20(2)(b) of the Animal Products Act 1999.

In relation to pasteurisers evaluation means an independent external assessment by a recognised person or recognised agency of the pasteuriser and its related heat treatment plan to determine compliance with regulatory requirements.

**FD Function Description:** a written description of the operations used to achieve a manufacturing process.

**Heat Exchanger** An indirect contact, either plate type or tubular type vessel, where the heat is transferred between two liquids of different temperature.

**HACCP** Hazard Analysis and Critical Control Point system adopted by the Codex Alimentarius Commission. HACCP is a systematic identification of hazards and the measures for their control to ensure the safety of food. It focuses on prevention rather than end-product testing.

**Heat Treatment Equipment** All equipment, including control systems/automation, used for pasteurisation.

**Heat Treatment Plan** A list or matrix of the documents necessary to meet NZFSA requirements relating to dairy heat treatments, which is contained within or referenced from an RMP. This list or matrix includes the document names, references and the locations where they are held.

The documentation should include:

design and “as-built” drawings, plating diagrams, computer or PLC programmes, operating procedures, training programmes and training records, to ensure that:

- staff and contractors have the knowledge and skills necessary to:
  - understand the hazards managed by the heat treatment;
  - understand the heat treatment and how it operates;
  - operate, check and maintain the heat treatment including monitoring, taking timely and appropriate corrective action(s) when there is “loss of control”, and record keeping; and
- the heat treatment is readily internally validated; and
- the heat treatment is readily evaluated and externally verified.

**HHST (Higher-Heat Shorter-Time pasteurisation)** Continuous pasteurisation utilising a temperature of 89°C and a holding time of 1 second. HHST pasteurisation shall comply with all requirements for HTST pasteurisation.

**HTST (High Temperature Short-Time pasteurisation)** Continuous pasteurisation utilising a temperature of 72°C and a holding time of 15 seconds, or an equivalent time-temperature combination, but not including batch pasteurisation.

**I/O** The inputs and outputs of a computer control system, e.g. measurements, valve signals, valve position feedbacks, etc.

**Logic** The programme contained within the computer control system to control diversion, etc.

**Milk** As defined by Codex Alimentarius - the normal mammary secretion of milking animals obtained from one or more milkings without either addition to it or extraction from it, intended for consumption as liquid milk or for further processing.

**Monitoring** The routine checks and tests carried out by the operator in order to determine that the pasteurising equipment is currently performing in accordance with the requirements of this code.

**Non-potable water** Any water that does not meet the definition of potable water.

**Operator** In relation to an animal product business, means the owner or other person in control of the business.

**Pasteurisation** is rapidly heating milk to a temperature of no less than 72°C and retaining it at that temperature for no less than 15 seconds; or rapidly heating milk to a temperature of no less than 63°C and retaining it at that temperature for no less than 30 minutes. Dairy material may be rapidly heated and held using a temperature and holding time combination with the same process performance as pasteurisation for the dairy material concerned.

**PLC** Programmable Logic Controller.

**Potable water** complies with “Drinking-Water Standards for New Zealand 2000”, published by the Ministry of Health, and is essentially water that is clean, drinkable and free from sediment, turbidity, colour, undesirable taste or odour, and chemical substances and micro-organisms in amounts that cause a hazard to health.

**Product (for the purposes of this code)** Means fluid, including dairy material, being subjected to dairy processing including pasteurisation. This term is used in context of process and equipment descriptions (e.g. product valve, product balance tank, product pump, product flow, etc.).

**Product contact surfaces** have contact or may have contact with milk, other dairy material or CIP solutions.

**Sanitary** The number of micro-organisms in the environment is at a level that does not compromise product safety or wholesomeness.

**Scan time** The time taken by the computer control system for each repeat of reading all the inputs, executing the logic once, and sending all output signals.

**Recognised agency** In relation to any function or activity, means a person or body recognised under Section 103 of the Animal Products Act for the purpose of performing that function or activity.

**Recognised person** In relation to any verification or other specialised function or activity, means a person recognised or accredited under Section 103 of the Animal Products Act to perform that function or activity.

**Significant change** Any change made to key staff, environment, premises, equipment, control systems/automation, facilities, process or product that may affect food safety.

**Stove Top Heat Treatment** A non-automated heat treatment undertaken in a vessel without fittings for pipe-work, e.g. a saucepan.

**Vacuum steam pasteurisation** Continuous pasteurisation utilising a process that combines a pasteurisation heat treatment with the process of removing taint-causing volatiles to acceptable levels by steam stripping while under vacuum.

**Validation (internal)** Means the process by which the dairy processor obtains evidence that the programme being validated is complete, will be effective in meeting the requirements of the Animal Products Act 1999, and any relevant animal product regulations and specifications, and when implemented will be able to consistently achieve the intended and required outcomes of the programme. Revalidate has a corresponding meaning.

**Validation (external)** means an external person or agency acting for the dairy processor to carry out the requirements of an internal validation.

**Verification (external)** means the ongoing checks carried out by a recognised person or agency to determine whether:

- a. Operations that are subject to a risk management programme or a regulated control scheme are, and have been, in compliance with the requirements of the programme.
- b. Animal material or products for whose export an official assurance is required have been produced or processed in a way that meets the requirements for official assurance.

**Wholesome** The dairy material or dairy product does not contain or have attached to it, or enclosed with it or in contact with it anything that is offensive, or whose presence would be unexpected or unusual in material or product of that description.

## 2 Heat Treatment to achieve Pasteurisation

### 2.1 Purpose of Pasteurisation

Pasteurisation is a heat treatment which reduces the number of harmful micro-organisms if present in milk and liquid milk products to a level at which they do not constitute a significant health hazard.

In addition, pasteurisation prolongs the shelf-life of dairy products while only causing minimal chemical, physical and sensory changes.

Pasteurisation of cows' milk results in a negative alkaline phosphatase reaction immediately after the treatment.

Phosphatase testing will identify milk that has not been pasteurised, but may not identify pasteurised milk which has been re-contaminated with small quantities (e.g. 0.5% or less) of raw milk. The best assurance that can be given regarding the effectiveness of pasteurisation is to use equipment designed, installed, operated and maintained in a manner which ensures that no untreated or partially treated milk passes forward.

Other higher temperature heat treatment processes, such as UHT methods, can be used to create extended shelf-life products. These can be processed with or without subsequent refrigeration and are safe and microbiologically stable during the intended storage period.

### 2.2 Non-conforming Dairy Material

Any dairy material heat treated in accordance with this code which is known or suspected to not meet the required outcomes for pasteurisation described below, shall be isolated, appropriately identified and/or labelled, secured against use, sale, or export, and managed as non-conforming dairy material in accordance with NZFSA requirements relating to non-conforming material. This shall include all finished product manufactured from such non-conforming dairy material. The cause for non-conformance shall be determined and rectified prior to continuing operation of the pasteurising equipment.

### 2.3 Required Outcomes for Pasteurisation

This code is based on the following required outcomes and explanations:

**2.3.1** Heat treatment temperature is measured and achieved

## Explanation

- The measured temperature shall be representative of the coolest zone
- No forms of cooling shall be present that could reduce the heat treatment temperature, e.g. for batch pasteurisation, the temperature control of the head space is to be at or above pasteurisation temperature
- There shall be double confirmation of the temperature, e.g. a cross check of measured temperature is required to be within a specified tolerance.

**2.3.2** Holding time is achieved

## Explanation for continuous pasteurisation

- The fastest particles at the maximum nominal flow shall be held in excess of the minimum holding time
- The flow shall be stable within the specified tolerance, and not subject to influences from external process
- The flow shall be fully developed laminar or turbulent flow, which is able to be measured. The Reynolds number for the flow shall be maintained out of the transitional zone, i.e. treat as laminar if  $Re < 4000$  otherwise turbulent
- Flow shall be single phase. No vapour or air inclusion or pockets shall form causing a two phase flow
- Where another stream is added (e.g. condensate from steam infusion) the volume of the condensate shall be allowed for
- Allowance shall be made for the response time and hysteresis of any instrumentation.

## Explanation for batch pasteurisation

- The time shall be measured from when the last particle reaches the set temperature.

**2.3.3** Corrective action system stops unpasteurised dairy material from feeding forward in the event of a failure

## Explanation



- 
- The corrective action system shall operate before the nominated time or temperature requirements are compromised. An allowance shall be made for:
    - thermodynamic and mechanical response time of instrumentation and divert mechanism;
    - response time of control system e.g. scan time of PLC;
    - any other factors causing delay in response.
  - Where the requirements are not met the dairy material shall be prevented from feeding forward and the equipment is:

either

- cleaned i.e. shut down and clean out all dairy material;

or

- bypassed i.e. avoid contamination of down stream process by operating divert path;

or

- sanitised i.e. downstream process heated to higher than pasteurisation temperature before recommencing feed forward.
- In the event of the operation of a corrective action system, an atmospheric break shall be created between the heat-treated and non-heat-treated dairy material to avoid siphoning. This may be achieved by valve configuration. If valves are used the bleed port shall be sufficiently sized to ensure the full flow will be diverted without pressuring the second block valve.

#### **2.3.4** Pasteurised dairy material does not come in contact with unpasteurised dairy material or untreated services

Explanation for short shelf life product

- Equipment that may cause contamination shall be continuously monitored for failure. In the event of the failure the equipment shall be stopped. Plate heat exchangers using regenerative heating and cooling sections are particularly susceptible to cracking and leaks

- Piping or other connections that potentially allow pasteurised and unpasteurised dairy material to be mixed shall be separated by an atmospheric break
- Sources of contamination shall be controlled, e.g. condensation, foam or splashes
- The cleaning process shall ensure harmful chemical contaminants are not left in the equipment.

Explanation for product with final product testing, and storage

- Equipment that may cause contamination may be continuously monitored or periodically monitored for failure. This may be achieved by pressure testing, helium tests, conductivity tests or visual checks of leakage chambers.

#### **2.3.5** Particle size is controlled to ensure sufficient heat transfer for all particles

Explanation

- A form of filtration or separation shall be included if there are any particles larger than those allowed for in the table in 2.4.4.

#### **2.3.6** Product contact surfaces are clean and sanitary before start up

Explanation

- A cleaning regime shall render all product contact surfaces “clean” (refer definition in section 1.3). Product contact surfaces should be monitored at an appropriate frequency to achieve a suitable microbiological standard
- The cleaning system should be monitored to ensure that it achieves a repeatable standard of cleaning.

#### **2.3.7** Cooling system (where required) is to bring dairy material temperature down to the level set in the Risk Management Programme

Explanation

- At the end of heat treatment and prior to further processing or storage, the dairy material shall be immediately heated or cooled to a temperature that maintains the dairy material in a wholesome condition either until further processing or for the duration of its shelf-life

- The failure of a cooling system shall be alarmed to the operator, with the appropriate action taken as per the Risk Management Programme
- Does not apply to evaporators or concentrate heaters where further processing is immediate.

### 2.3.8 Continuous collection and recording of critical parameters

#### Explanation

The following parameters shall be monitored if applicable to the equipment:

- pasteurisation temperature;
- flow or time;
- pressure or differential pressure;
- operational mode (production or CIP) and operation of corrective action system;
- cooling temperature where dairy material is cooled immediately after heat treatment.

Furthermore:

- Recording shall be continuous or at intervals sufficiently short to distinguish between significant changes of critical parameters
- Daily checks shall be carried out to prove temperature measurement and diversion systems are operating correctly. This shall be recorded for each critical parameter prior to producing pasteurised dairy material
- Where filters are used to remove particulate matter, filter inspections shall be recorded (refer sections 7.4.1.6 and 8.11)
- Records shall be kept for monitoring of the cleaning effectiveness and sanitary condition prior to start-up
- The records and data shall be readily accessible to the operator
- The records and data shall be stored in a secure and protected manner, which can be easily retrieved.

### 2.3.9 Secure control systems that are protected from tampering

#### Explanation

- The control system set points and logic require protection from unauthorised changes. To achieve this, security shall be built into the control equipment so that once the control system is validated it remains unchanged
- The set points and programme options selected shall be able to be verified, after the event, that the correct selection was made
- For computer control systems with communications which extend wider than the heat treatment equipment, overwriting of programme and other interference with the control system or recording is prevented, e.g. input/output signals, external communications on a network, Internet connections
- Any changes to the control system, critical parameters or equipment shall have a change control programme that includes the reviews above as well as authorisation and sign off for the changes. Records of the above shall be kept and be available for auditing.

### 2.3.10 Failsafe operation in the event of service failures

#### Explanation

- The control systems shall be set up so the loss of services or failure of a component causes the system to failsafe, i.e. rest position does not feed dairy material forward
- The data collection and recording device shall either continue to operate during a power failure or the equipment shall be designed to divert with the power failure.

### 2.3.11 Ability to validate, inspect and demonstrate compliance

#### Explanation

There shall be provision:

- included for calibration and cross checking of instruments critical to the pasteurisation system;
- for measuring of critical items, such as speed of response tests;
- for direct measurement of holding time, e.g. by completing salt solution tests;
- to test recording devices, e.g. PLC programme scan time, and chart recorders.

The pasteuriser shall be designed, constructed, and installed so that all elements or items used for validation, verification, calibration, routine operation, and routine checking, are readily and safely accessible to relevant personnel.

## 2.4 Heat Treatments

Pasteurised dairy material is rapidly heated to at least the temperature and holding time combinations specified for the composition of the dairy material concerned in the three sections below.

### 2.4.1 Dairy material with less than 10% fat, and up to 15% total solids, and without added sweeteners

Dairy material with no added sweeteners, and less than 10 percent fat, and 15% total solids or less, is considered to be pasteurised when it has been heated to and held at the minimum temperature for the minimum holding times specified in the table in section 2.4.4:

- Column A1, for dairy material containing particles less than 200 µm diameter
- Column A2, for dairy material containing particles 200 µm to less than 500 µm diameter
- Column A3, for dairy material containing particles 500 µm to less than 1000 µm diameter

### 2.4.2 Dairy material with 10% fat or greater, and/or greater than 15% total solids content, and/or containing added sweeteners

Dairy material with added sweeteners, or 10 % fat or greater, or greater than 15% total solids, is considered to be pasteurised when it has been heated to and held at the minimum temperature for the minimum holding times specified in Table in 2.4.4:

- Column B1, for dairy material containing particles less than 200 µm diameter
- Column B2, for dairy material containing particles 200 µm to less than 500 µm diameter
- Column B3, for dairy material containing particles 500 µm to less than 1000 µm diameter

### 2.4.3 Ice cream mixes containing particles up to 1000 µm diameter

Ice cream mixes containing particles up to 1000 µm diameter are pasteurised when they have been heated to and held at the temperature for the holding times specified in Table in 2.4.4 (Column C).

**2.4.4 Other Dairy Material**

In cases where the composition or particle size of dairy material is outside the limits specified above, alternative heat treatment criteria require HACCP validation, to demonstrate the effectiveness of the time temperature combination in controlling the hazard(s). Such alternate criteria shall have formal written approval by NZFSA prior to use in processing.

**Table: Equivalent Heat Treatments for Common Types of Dairy Material**

	A1	A2	A3	B1	B2	B3	C
	<b>All dairy material (excluding ice cream)</b>						<b>Ice cream mixes</b>
	<b>Dairy material with &lt;10% fat, and ≤15% total solids, and without any added sweeteners</b>			<b>Dairy material with ≥10% fat, and/or &gt;15% total solids, and/or with added sweeteners</b>			
<b>Particle Diameter</b>	<b>&lt;200 µm Ø</b>	<b>200 to &lt;500 µm Ø</b>	<b>500 to &lt;1000 µm Ø</b>	<b>&lt;200 µm Ø</b>	<b>200 to &lt;500 µm Ø</b>	<b>500 to &lt;1000 µm Ø</b>	<b>with particles &lt;1000 µm Ø</b>
<b>Minimum holding time (seconds)</b>	<b>Minimum temperature (°C)</b>						
1	81.6	-	-	84.4	-	-	-
2	79	81.6	-	81.8	84.4	-	-
3	77.6	79	-	80.4	81.8	-	-
4	76.5	77.6	81.6	79.3	80.4	84.4	-
5	75.7	76.5	79	78.5	79.3	81.8	-
6	75.1	75.7	77.6	77.9	78.5	80.4	-
7	74.6	75.1	76.5	77.4	77.9	79.3	-
8	74.1	74.6	75.7	76.9	77.4	78.5	-
9	73.7	74.1	75.1	76.5	76.9	77.9	-
10	73.3	73.7	74.6	76.1	76.5	77.4	85.5
11	73	73.3	74.1	75.8	76.1	76.9	-
12	72.7	73	73.7	75.5	75.8	76.5	-
13	72.4	72.7	73.3	75.2	75.5	76.1	-
14	72.1	72.4	73	74.9	75.2	75.8	-
15	72	72.1	72.7	74.8	74.9	75.5	79.5
30	70.7	70.8	70.9	73.5	73.6	73.7	-
60	69.4	69.4	69.5	72.2	72.2	72.3	-
<b>Minimum holding time (minutes)</b>	<b>Minimum temperature (°C)</b>						

1	69.4	69.4	69.5	72.2	72.2	72.3	-
2	68.1	68.1	68.1	70.9	70.9	70.9	-
5	66.4	66.4	66.4	69.2	69.2	69.2	-
10	65.1	65.1	65.1	67.9	67.9	67.9	74
15	64.3	64.3	64.3	67.1	67.1	67.1	-
20	63.8	64.8	64.8	66.6	66.6	66.6	69
25	63.3	63.3	63.3	66.1	66.1	66.1	-
30	63	63	63	65.8	65.8	65.8	-

**Notes for Table**

1. Ø signifies particle diameter
2. Minimum holding time

The minimum holding time is set at 1 second to give an adequate safety margin. Shorter holding times will require validation to demonstrate the effectiveness of the time/temperature combination in controlling the hazard(s).

3. Minimum temperatures

The values in column A1 for times t < 15 seconds are calculated from the following pasteurisation effect equations based on equations in IDF Bulletin 200, 1986, "Pasteurized Milk", which are derived from experimental data.

$T = 14885 / (\log_{10} t + 41.97) - 273.1$	where T = minimum temperature in °C. t = minimum holding time in seconds.
---	--

The values in column A1 for times t ≥ 15 seconds are calculated from the equation below which is based on a log-time plot of the time temperature combinations 63°C/30 min and 72°C/15 s.

$\log_{10} t = -0.23102T + 16.03139$	Where t = minimum holding time in minutes T = minimum temperature in °C
--------------------------------------	--

The values in column B1 are based on the US FDA requirement that if the fat content of the dairy material or whey is 10% or more, or if it contains added sweeteners, or is condensed milk or condensed dairy product, the

specified temperature is increased by 2.8 °C (5 °F). This 2.8 °C increase has been applied to values in Column A1.

The values in column C are taken from the New Zealand Food Regulations 1984.

#### 4. Lowest allowable temperature

The pasteurising temperature given for a 30 minute holding time is the lowest allowable temperature for pasteurising the specified product types, i.e. a lower temperature for a holding time longer than 30 minutes is not acceptable.

#### 5. Particle sizes

The values in column A2 and B2 are based on calculations by Dr Ken R. Morison at Canterbury University that:

- Where the minimum temperature is 72°C or greater an adequate heat treatment for particles of 500 microns diameter can be estimated by applying a 0.7 second increase in minimum holding time at any specified temperature to the values for liquid dairy material. This 0.7 second increase with adjustment for rounding of holding time to the next whole second has been applied to values in Columns A1 and B1.
- Where the minimum temperature is less than 72°C, the additional holding time for particles of 500 microns diameter becomes relatively less significant compared to the total holding time. For a 30 second holding time an additional 0.1°C to the minimum specified temperature is required. For holding times of 60 seconds or longer no additional heating is required.

The values in column A3 and B3 are based on calculations by Dr Ken R. Morison at Canterbury University that:

- Where the minimum temperature is 74.8°C or greater an adequate heat treatment for particles of 1000 microns diameter can be estimated by applying a 3.0 second increase in minimum holding time at any specified temperature to the values for liquid dairy material. This 3.0 second increase has been applied to values in Columns A1 and B1.
- Where the minimum temperature is less than 74.8°C, the additional holding time for particles of 1000 microns diameter becomes relatively less significant compared to the total holding time. For a 30 second holding time an additional 0.2°C to the minimum specified temperature is required. For a 60 second (1 minute) holding time an additional 0.1°C to the minimum specified temperature is required. For holding times of 2 minutes or longer no additional heating is required.

#### 6. Holding times

The holding times specified in this section are minimum holding times and are based on all the liquid being held at or above the minimum stated holding temperature. To ensure uniform heat treatment the liquid temperature does not vary more than 0.5°C across the diameter of the holding tube (for continuous systems)



or within the holding tank (for batch holding vessels). Variation in flow velocity across the diameter of holding tubes is considered when calculating holding time.

Turbulent flow is demonstrated by calculation of the Reynolds number (Re). Laminar flow (assumed if the Reynolds number is less than 4000) is allowable. In this case the holding time is calculated, and the maximum velocity is taken as twice the average velocity based on the maximum flow rate.

#### 7. Use of steam

Where steam is introduced into dairy material to assist in a temperature change, the volume of the condensed steam is included when calculating the volume of product present in the holding tube.

---

## 3 Design and Fabrication of Pasteurisation Equipment

### 3.1 General Design and Fabrication Requirements

3.1.1 All pasteurisation equipment shall be designed, constructed and maintained to prevent the contamination of:

- pasteurised dairy material with unpasteurised dairy material;
- all dairy material with chemicals or extraneous matter.

The pasteurisation equipment, including gaskets, hygiene seals, fittings and other product-contact surfaces, shall be designed and fabricated in accordance with good manufacturing and food application practice. To comply with this, a design and fabrication standard shall be nominated against which the work can be audited. The standard nominated shall be acceptable to and approved by NZFSA.

The preferred method of preventing the contamination of pasteurised dairy material with unpasteurised dairy material is to have no piped connections for product or CIP that connect between the raw and pasteurised sides of the pasteuriser (“cross connections”), particularly where dairy product is not tested for food safety before release for human consumption.

3.1.2 If cross connections are essential, additional safety measures shall be taken to eliminate the risk of contamination of pasteurised dairy material with unpasteurised dairy material. One of the options in section 3.2, “Acceptable Cross Connections”, will achieve this.

Note: Cross connections that occur outside what is normally regarded as a pasteuriser shall still conform to these requirements, e.g. CIP return lines.

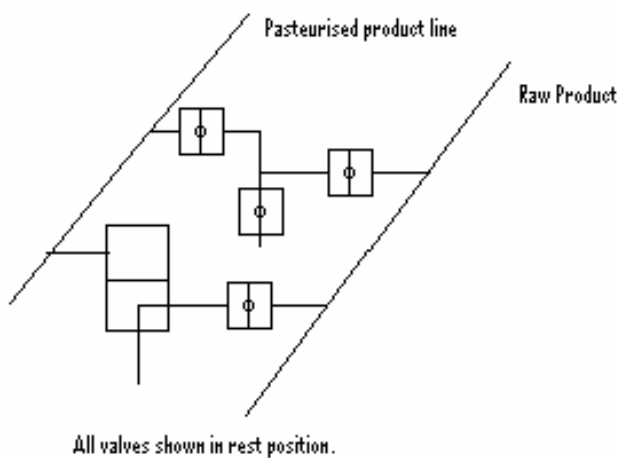
### 3.2 Acceptable Cross Connections

Cross connections do not include flow divert valves. This section deals with valves or key pieces that do not change position while in production mode.

### 3.2.1 Option 1 - Cross connection with valves

- The system shall incorporate a minimum of two valve seats (double block) and an atmospheric break (bleed) between these.
- The following diagram is included for clarity, and is not intended to limit other valve options that achieve the same outcome.

#### Diagram: Cross Connections with Valves (2 arrangements shown)



- The port size of the drain line shall allow flow through the connecting line without significant pressure drop.
- The drain valve shall be open to drain at all times, except during CIP. The block valves shall be closed at all times, except during CIP. The drain valve shall fail open.
- Any leakage from the block valves shall be toward the drain and away from the pasteurised product block valve.
- Any valves used in cross connections shall meet the leak testing requirements for divert valves in section 7.4.3, "Three-Monthly Checks" of this Code. Valve seats shall have a double safety connection to the valve stem to maintain the integrity of the connection between the valve seats and the valve stem.
- Valves used for cross connections shall be fitted with valve position feedback sensors.

The preferred method is for the valve position feedback signal to be generated from the position of the valve stem. If the signal is generated from the position of the valve actuator shaft rather than the valve stem, the valve stem shall have a double safety connection to the actuator shaft to maintain the integrity of the connection between the valve stem and the actuator shaft.

Note: a screwed connection that is also pinned through both the actuator shaft and the valve stem, a bolted connection that also has the nut pinned through the bolt, or use of a chemical locking agent applied in accordance with the manufacturer's instructions would satisfy this requirement.

Where butterfly valves are used, the feedback shall be taken from the valve shaft.

### 3.2.2 Option 2 - Cross connections using manually positioned pipes

Cross connections using manually positioned pipes shall:

either

- create a physical atmospheric break so there is no direct cross connection between unpasteurised dairy material and pasteurised dairy material, e.g. a recycle or CIP line entering the balance tank above the liquid level acts as a safety break in conjunction with the key pieces;

or

- be manually positioned key pieces arranged in such a manner that at least two proximity switch feedbacks have to change state when changing a key piece from production mode to CIP mode. The proximity switch feedbacks shall be incorporated into the control system so that the correct feedback is received from all the switches at all times that contamination is possible.

### 3.2.3 Software control for systems including cross connections

Software controlling and checking the position of valves or proximity switches associated with any cross connections between raw and pasteurised pipelines shall comply with section 4, "Computer Control Systems" of this Code.

The I/O associated with cross connecting valving or manually positioned keypieces shall be treated as critical food safety items and shall comply with section 4.3.2, "Input/Output Security" of this Code.

### 3.2.4 Recording of safety feedback positions

The position of all keypieces and product security valves for a pasteuriser cross connection shall be displayed and recorded at all times when cross contamination may occur. This will usually include when the pasteuriser is not in operation.

Either

- the product security valve positions may be incorporated into one recording trace and shall be on the same chart or trend as the record of the production/CIP status.

or

- when an alternative electronic data recording system is used, the positions need only be recorded in an event log (refer to section 5.4, “Data Recording Systems”).

Recording of the CIP/production status is required for pasteurisers with a divert valve override for cleaning (section 5.4.1.5, “Chart Recorder”), as well as for all pasteurisers with cross connections between pasteurised dairy material and unpasteurised dairy material.

### 3.2.5 Activation

If, at times other than during CIP, the cross connection valve position feedback signals or any of the product safety proximity switches on cross connecting flow plates do not indicate a “safe” position:

either

- the raw material supply to the pasteuriser raw material balance tank shall be stopped immediately;

or

- the pasteuriser shall recycle if a recycle valve is fitted, or the pasteuriser shall divert.

If during CIP, any position feedback signal from a cross connection valve or from a manually positioned swing bend on a cross connecting flow plate indicates a “safe” position when they have been commanded to energise, then the fault shall be latched to prevent the pasteuriser going back into production until the operator has acknowledged that the feedback error has been recorded and corrected.

The site Risk Management Programme shall contain written procedures to evaluate any product hazard that may have occurred during the cross connection failure and shall set out recovery procedures to be followed before the pasteuriser can restart production.

## 3.3 Materials

**3.3.1** Incidental contact with milk, other dairy material, or CIP solutions shall be made of austenitic stainless steel (grade 304 or better) or other stainless steels or materials accepted by NZFSA as being of food grade and suitable for purpose.

**3.3.2** Welded joints shall have a strength and corrosion resistance equal to that of the parent metal. The product contact surface of welds shall be smooth and free from crevices, pits and oxidation.

**3.3.3** Stainless steel product contact surfaces shall have a surface roughness (Ra) less than or equal to 1 micron (1µ m) at fabrication.

**3.3.4** Materials used for seals shall be fat-resistant, non-toxic, resistant to cleaning agents and disinfecting agents in normal concentrations and at normal temperatures, shall not impart a taint to dairy material, and shall be accepted by NZFSA as being of food grade.

#### **3.4 Cleaning Systems**

**3.4.1** If plant is to be cleaned by hand, it shall be constructed so that it can be readily dismantled for inspection, cleaning and sanitising.

If plant is designed for automated cleaning, it shall be constructed for CIP and shall have suitable provision for the inspection of representative sections of pipe work and plant. This is particularly applicable to plant such as vacreators or spinning cone type systems.

**3.4.2** There shall be documented procedures on how the product contact surfaces of a pasteuriser will be effectively cleaned and sanitised prior to dairy material entering the plant.

The documentation shall include the cleaning and sanitising procedures necessary for recovery from unplanned stoppages and events such as:

- services failure;
- equipment failure;
- instrument failure;
- intrusive maintenance.

**3.4.3** All product safety functions (temperature diversion, high flow rate protection, differential pressure recycle, computer monitoring of scan rate, and equipment and instrument failure) shall be actively monitored and controlled at all times after the start-up sanitation step.

If control of any product safety function ceases at any stage, all affected product contact surfaces downstream from the primary divert valve shall be effectively sanitised (refer to section 3.4.2) prior to the resumption of production. For example, if the pasteuriser is flushed with water between processing different dairy materials, and the temperature divert function is disabled to allow low-temperature, potable water shall be flushed out of the raw material side of the pasteuriser through the forward flow lines, production shall not resume until all product contact surfaces downstream from the primary divert valve up to the point of discharge of the water have been effectively sanitised.

## 4 Computer Control Systems

### 4.1 Design Requirements

Computer control systems are used for most modern control operations. They shall address the following four differences between hard-wired and computer control systems:

#### 4.1.1 There is a discrete time execution of logic

Hard-wired systems operate continuously, but computer control systems generally execute logic sequentially and there is a finite time between each execution of the logic. A complete scan will involve the processes of scanning the inputs, executing the logic and sending all the output signals. Typically this takes less than 100 milliseconds, but some computer control systems are slower. In some systems only some of the logic is executed during normal operation, but on occasions other logic may also be executed and the time between scans can become unacceptably high.

#### 4.1.2 The control logic can be changed with relative ease and I/O can be easily forced

Control logic can be changed with relative ease using programming tools that are often easily accessible. It is much less likely that hard-wiring changes are made without care and testing. When the pasteurisation logic is part of a large system, in which changes are sometimes made, there is an increased risk of intentional, or unintentional, changes to the pasteurisation software. A computer control system needs to be adequately protected against changes that may compromise public health. Further, in some systems, there is access to force input or output values in a manner that overrides the logic. This is unacceptable during pasteurisation.

#### 4.1.3 Data can be stored electronically rather than printed continuously

Electronic data storage offers an opportunity to provide a clear record that pasteurisation was achieved. Some systems do not always provide a record that clearly shows the critical parameters of pasteurisation. Special considerations are required to ensure that an adequate record that contains sufficient information is kept. Further, electronic data storage is discrete rather than continuous, and there is a risk that some data may be missed.



#### **4.1.4** Digital signals rather than hard-wiring are used for communication

Many computer control systems are designed to operate with minimal intervention from human operators. Communication may be carried out by means of a digital communication “highway” which is used to initiate processes and to extract data. This communication system shall be set up to ensure that it does not provide a means by which the operation of the logic or the I/O can be altered.

### **4.2 Scan Time**

**4.2.1** The control system shall ensure that it scans the I/O and executes the logic sufficiently often so that no unpasteurised milk can pass forward if pasteurisation conditions are lost.

**4.2.2** The time taken to carry out a complete scan of all inputs, execute the programme, send all outputs and return to the start shall be less than 1.0 seconds. The dairy processor may nominate a maximum scan time of less than 1.0 seconds for the purposes of sections 4.2.4 and 4.2.6.

**4.2.3** In any system in which the scan time may be variable, the logic shall contain a timer, accurate to 0.1 seconds, to monitor the time taken per scan.

**4.2.4** If the scan time exceeds the maximum nominated scan time, the pasteuriser shall divert and recycle (if a recycle valve is fitted) (refer to sections 19.2.2, “Activation” and 20.3.4, “Activation”).

**4.2.5** Operator interface operations, printing of any information or external communication shall not interrupt the logic to such an extent that the required scan time is not met.

**4.2.6** The system response time as defined in sections 5.4.1.9, “Response Times” and 19.3.5, “Response time of the pasteurising temperature recorder and flow diversion system” and 20.2.2, “Response time of the differential pressure recorder and recycle system”, shall also include the maximum scan time of the system, e.g. the temperature system response time equals one time constant of the temperature sensor plus the time taken from the divert temperature being reached until the valve is in the fully diverted position plus one scan time.

**4.2.7** The scan time shall be able to be displayed for checking.

### **4.3 Security**

#### **4.3.1 Programme security and records**

**4.3.1.1** It is essential that the programme controlling the critical product safety functions of pasteurisation cannot be changed without appropriate authorisation and documentation. Suitable documented procedures shall be put into place to ensure that no unauthorised changes are made, that the programme is error-free and that records are kept as part of the quality assurance record.

Where more than one PLC is included in a system where it is possible to globally address the I/O, the software shall be configured to ensure that no unauthorised changes can be made or access can be gained to these points from external sources.

For new installations a stand-alone control system shall be dedicated to pasteuriser product safety functions, to ensure programme and I/O security, and facilitate the validation process. It is desirable, but not mandatory, that existing installations are equipped with a stand-alone control system dedicated to pasteuriser product safety functions, to help ensure programme security and I/O security, and facilitate the validation process. Existing installations shall be converted to a stand-alone control system whenever there is any upgrading of the control system hardware.

**4.3.1.2** Access to the logic shall be locked by means of a physical lock, seal or password protection to prevent unauthorised changes.

**4.3.1.3** The programme security system shall have documented procedures for making programme changes, and shall identify the:

- person (usually the factory manager) who may authorise a change;

- person/s who may make the change;
- required documentation.

The required documentation (which may be in secure electronic form) shall include:

- the reason for the change;
- written details of the change, including a function description (FD) where appropriate;
- the authorised person's signature and the date that the change was authorised;
- the signature of the person who made the change and the time and date that the change came into effect;
- confirmation that a back-up of the software has been made after the change (see section 4.3.1.6);
- a print-out of the relevant product safety part of the pasteurisation programme (see section 4.3.1.7).

4.3.1.4 Logic should be as simple and explicit as possible.

4.3.1.5 The control logic should be stored in memory or on hard disk and be available on power up. Tapes, floppy disks or diskettes should not be used, as there is no guarantee that the correct programme will be reloaded.

4.3.1.6 A backup of the software should be made after every programming change and before locking.

4.3.1.7 The relevant product safety part of the pasteurisation programme shall be printed after any programme changes. This copy shall be retained. The programme shall include plain English descriptors so that it can be readily audited. Often an FD is required to assist in navigating through the logic; again this shall have plain English descriptors and/or a key so that it can be readily audited.

4.3.1.8 All the logic required for each pasteuriser should be contained within a single block of network or programme text.

4.3.1.9 Where there are multiple pasteurisers being controlled, the logic for each should be distinct.

#### **4.3.2** Input/output security

4.3.2.1 It is essential that only the pasteurisation computer controls inputs/outputs (I/O). It shall not be possible for I/O to be changed by other programmes or systems or by operators.

4.3.2.2 Except for testing, there shall be no manual override available to an operator either via the operator interface or on the I/O device to force the position or value of any critical input or output. Where manual operation is required for normal testing, this shall be explicitly programmed into the logic.

4.3.2.3 Critical process I/O shall be operated only by the computer designated for control. There shall be no hardware or software link that would allow another control system to change any I/O values directly.

4.3.2.4 The power up state of all critical I/O shall be failsafe.

4.3.2.5 The programme shall contain checks for each critical measurement and valve as required in sections 3.1.2, 19.2.2, "Activation", 19.3.6, "Timing of valve returning to forward flow position" and 20.3.4, "Activation" of this code.

4.3.2.6 All critical I/O shall be enabled (unforced) before the control system is locked after any modifications and before pasteurisation.

4.3.2.7 In the case of failure of the computer control system (e.g. CPU failure or I/O network failure), the I/O and field device shall go to a failsafe position.

#### **4.3.3** Operator control

The operator may be able to, by means of a switch or by communication from a supervisory system:

- start and stop the pasteuriser;
- start and stop CIP;
- carry out test procedures which do not compromise product safety requirements;
- view process measurements, setpoints and the scan time;
- view the status of faults.

The operator shall not be able to force any critical input or output and shall not be able to override any critical value displayed or recorded by the system.

The operator shall not be able to change any critical parameters, i.e. the pasteurisation temperature divert setpoint, the differential pressure recycle setpoint or the maximum flow rate divert setpoint.

#### **4.4 External Communication**

**4.4.1** Some computer control systems enable remote control and communication from other control systems. This external communication shall be controlled to ensure that it is not possible to interfere with the logic or I/O.

**4.4.2** External communication may be used to:

- start and stop pasteurisation;
- start and stop CIP;
- carry out test procedures that do not compromise product safety requirements;
- read data from the computer control system.

**4.4.3** External communication shall not control I/O directly but may command the programme to operate in a predefined mode.

**4.4.4** External communication shall be failsafe. In the case of an ambiguous command or no command, the system shall divert or recycle.

**4.4.5** Where there is external communication to a recording system, there shall be a facility to alert the operator if the data is no longer accurately recorded due to communication errors or failure.

---

## 5 Data Collection and Recording System

### 5.1 Purpose

The pasteuriser shall have a data collection and recording system with the following elements:

- log sheets for manual data recording;
- a circular or strip chart, or an electronic data recording system, to ensure a “continuous” (see section 5.4.1.7), permanent and accurate record of pasteurisation is maintained.

### 5.2 Data Sensing

#### 5.2.1 Temperature sensing systems

All temperature sensing systems that have a food safety function shall comply with the following:

- be accurate to within 0.5°C in the range 3°C above and below the pasteurising, air space or cooling setpoint;
- have protection against damage in the range 0-100°C;
- have a time constant of no greater than 5 seconds.

The time constant for a temperature sensing system can be measured by immersing the cold sensor in a well-stirred water bath at 76.0°C. The time interval between when the indicator reads 65.0°C and when the indicator reads 72.0°C is one time constant for the sensing system.

The sensors (and associated sensor pockets where fitted) shall be readily removable to allow testing to take place and be mechanically protected where necessary.

#### 5.2.2 Differential pressure sensing systems

Where required, the differential pressure shall be measured, monitored and recorded with a differential pressure transmitter, two pressure transmitters or a differential pressure switch with pressure indication.

All differential pressure sensing systems that have a food safety function shall comply with the following:

- be accurate to within 2 kPa over the range 10 kPa above and below the differential pressure setpoint.
- have a time constant no greater than 5 seconds.

The time constant for a differential pressure sensing system can be measured by raising the pressure to 27.5 kPa, then rapidly dropping the pressure to 0 kPa. The time interval between the instrument reading 27.5 kPa and 10.0 kPa is one time constant for the instrument. (Note: this test shall be performed on the pressure sensors on both the high and the low sides of the differential pressure sensing system.)

### **5.2.3 Location of pressure sensors**

Pressure sensors shall be installed at appropriate locations to monitor differential pressures.

This requires pressure sensors for the pasteurised dairy material to be located at the lowest pressure point of the section concerned (usually the exit) and for the raw material, heating, cooling and chilling media to be located at the highest pressure point of the section concerned (this may be the entry or exit point). More than one sensor will be required on the raw material side if there is more than one regeneration section in a heat exchanger.

Sensors shall be mounted as close as practicable to the same height and any static head difference shall be taken into account when determining the pressure difference.

## **5.3 Data Indicating Systems**

### **5.3.1 Temperature indicating systems**

#### **5.3.1.1 Non-digital temperature indicators**

Non-digital temperature indicating systems shall:

- have scale divisions of less than or equal to 0.5°C;
- have no more than 2°C/cm of scale.

Glass thermometers shall:

- not be installed in such a way that they can come into contact with dairy material;



- be protected from accidental damage.

#### 5.3.1.2 Digital temperature indicating systems

Digital temperature indicating systems shall:

- have a scan frequency of no greater than 1 second;
- have a resolution of 0.1°C.

#### 5.3.1.3 Cross check temperature indicators

Cross check temperature indicators shall be installed to enable the following temperatures to be read during plant operation:

- the dairy material temperature, at a position as close as practicable to the pasteurising temperature sensor;
- where critical to food safety, the dairy material temperature, at a position as close as practicable to the cooling temperature recording sensor.

If more than one pasteurising sensor is used, each sensor shall have an associated cross check temperature indicator.

The operator shall be able to view the cross check temperature indicator and the pasteurising temperature simultaneously.

If the cross check temperature indicator is a digital instrument, it shall:

- be totally independent of the recording and computer control system;
- have its own sensor and power supply and display.

#### 5.3.1.4 Computerised temperature comparisons

Continuous computerised comparison of the cross check temperature and the temperature recorder may be carried out if desired.

The cross check temperature signal used for computerised comparison shall be totally independent from the cross check temperature signal used for the daily logging requirement. One way of achieving this is by installing a double temperature sensor in the cross check temperature position.

A computerised comparison does not replace the requirement for the daily reading and logging of the temperature from the independent cross check thermometer and the recorder as described in section 7.4.1.2, "Temperature" of this code.

### 5.3.2 Pressure indicating systems

Individual pressures from both low and high pressure sensors shall be displayed for daily checking and calibration purposes. The individual pressures may be displayed at the pressure sensing devices and in the case of pressure differential switches need not be transmitted back to the computer control system.

## 5.4 Data Recording Systems

### 5.4.1 Chart recorders

#### 5.4.1.1 Chart ranges

- The temperature range shall include temperatures 5°C above and below the diversion temperature.
- The differential pressure range shall include 0-20 kPa.
- The flow range shall include the maximum operating flow rate  $\pm 10\%$ .

#### 5.4.1.2 Chart gridlines

- The temperature gridlines shall be not more than 0.5°C represented by spacings of not less than 1 mm within the range specified above.
- The pressure gridlines shall be not more than 2 kPa represented by spacings of not less than 1 mm.
- The flow rate gridlines shall be not more than 2% of the maximum operating flow rate represented by spacings of not less than 1 mm.

#### 5.4.1.3 Chart accuracy

- The temperature recording shall be accurate to within  $\pm 0.5^\circ\text{C}$  over the range 3°C above and below the diversion temperature.

- The differential pressure recording shall be accurate to within  $\pm 2$  kPa over the range 10 kPa above and below the differential pressure diversion setpoint.
- The flow rate recording shall be accurate to within  $\pm 5\%$  at the maximum operating flow.

#### 5.4.1.4 Time intervals

Time intervals shall be represented by lines with a spacing that represents not more than 15 minutes separated by not less than 5 mm at the diversion temperature.

#### 5.4.1.5 Chart recorder

The chart recorder shall be capable of recording at all times the mode of the diversion devices, i.e. forward-flow or diverted.

Where cleaning systems have a divert valve override, or where there are data recording requirements for cross connections between pasteurised dairy material and unpasteurised dairy material or chemicals (see section 3.2.3), the pasteuriser status (distinguishing at least between cleaning and production) shall be recorded.

#### 5.4.1.6 Printed temperature trend

The printed temperature trend shall be resolvable to better than  $0.2^{\circ}\text{C}$  and shall be sensitive to changes of  $0.2^{\circ}\text{C}$ .

#### 5.4.1.7 Requirements for “continuous” recording

The requirements for “continuous” recording shall be deemed to be met provided the chart recorder recording update interval is no more than 5.0 seconds for each channel. The recorder shall have a test mode that allows the recorded temperatures and pressures to be displayed at the scanning interval.

#### 5.4.1.8 Location of chart recorder

The chart recorder shall be located in a position readily accessible to process operators.

#### 5.4.1.9 Response times

The chart recorder system response times shall be all less than 5 seconds. The system response time for the chart recorder is the sum of the time constants for the temperature or

differential pressure sensors and the time taken by the recorder to register the changes in signals on the chart.

#### 5.4.2 Electronic data recorders

5.4.2.1 Electronic data storage and periodic printing can be used to imitate a chart recorder or it can be used to provide an alternative record that pasteurisation was achieved at all times. The printed trend and any associated event log shall by itself provide an assurance that pasteurisation was achieved.

5.4.2.2 There shall be some form of data retrieval which would allow an operator to review the recorded data since the previous printout.

5.4.2.3 The datalogging system shall be designed to ensure that, in the case of power failure, all data is recorded up to the time that pasteurisation ceases. An uninterruptable power supply may be required to achieve this.

5.4.2.4 The datalogging interval shall be no more than 5 seconds except when data compression is used and there is no change in the data.

5.4.2.5 Temperature records shall have a resolution of 0.1°C and the software shall record any changes of 0.1°C or greater, i.e. any data compression deadbands shall be less than 0.1°C.

5.4.2.6 Flow rate records shall have a resolution of 2.0% of the maximum flow rate. Differential pressure records shall have a resolution of 2 kPa.

5.4.2.7 The trend shall be printed prior to every change of shift or operator so that the operator responsible for the pasteuriser during that period can check the printed trend for completeness and accuracy, and sign and date it (refer to section 7.4).

The review of trend data signed by the operator should be checked and counter-signed by the operator's supervisor or manager to minimise risk of failing to detect "pasteurisation alerts".

5.4.2.8 The printed trend of the pasteurisation temperature and differential pressure shall show the minimum values scanned.

Note: some programmes print average values or spot values. Typically up to 500 data points are chosen from the database for a plot, but with 5-second logging there are 720 points per hour. For a 5-hour trend only one point in seven will be represented. The minimum and not the average of these seven points shall be shown.

5.4.2.9 If a flow trend is required this shall show the maximum values of flow rate.

5.4.2.10 Instead of chart gridlines as specified in section 5.4.1.2, "Chart gridlines", the diversion temperature, differential pressure and flow rate setpoints may be plotted.

5.4.2.11 All other requirements in section 5.4.1, "Chart recorders", shall apply.

### 5.4.3 Alternative electronic data recorders

5.4.3.1 An alternative record may be produced which complies with section 5.4.2 but does not comply with sections 5.4.1.2, "Chart gridlines" and 5.4.1.4, "Time intervals" if it satisfies the following conditions:

- A 24-hour period shall be represented by not less than 20 cm.
- The diversion temperature, differential pressure and flow rate setpoints shall also be plotted on the same trend as the divert temperature, differential pressure and flow rate.
- An event log, which shall be stored with the trend, shall include the date, time (with a resolution of +1 s) and all events necessary to demonstrate that the diversion system and recycle system were functioning correctly.

These events could include:

- daily divert test;
- production start;
- production stop;
- CIP start;
- CIP stop;

- 
- pasteurisation temperature low;
  - pasteurisation temperature recovered;
  - primary divert valve diverted;
  - primary divert valve going forward;
  - secondary divert valve diverted;
  - secondary divert valve going forward;
  - recycle valve recycling;
  - recycle valve going forward;
  - differential pressure too low;
  - flow too high;
  - cross connection between raw and pasteurised pipeline link failure;
  - daily differential pressure recycle and/or flow diversion test;
  - differential pressure recovered;
  - flow rate recovered.

Events do not need to be recorded between CIP start and stop, except cross connection failure, which shall be recorded at all times, including production, cleaning and shutdown.

5.4.3.2 All divert and cross-connection valve and flowplate positions shall be recorded in the event log where the valve position is not recorded on the trend.

## 6 Critical Parameter Security

### 6.1 General

The critical control setpoints of pasteurisation temperature divert, differential pressure recycle and maximum flow rate divert shall be protected to prevent unauthorised alterations. However, the settings shall be readily accessible for checking values.

### 6.2 Alterations to Critical Parameters

Written procedures shall be maintained covering changes to critical parameters. The procedures shall stipulate who is authorised to make changes, instances when changes can be made, and records to be kept (refer to section 4.3.1.3).

---

## 7 Testing and Calibration

### 7.1 General Requirements

This section describes the requirements for validation, evaluation, monitoring, calibration, and verification of pasteurisers.

The pasteuriser shall be designed, constructed, and installed so that all elements or items used for pasteuriser control systems, instrumentation systems, computer programmes and safety features are readily accessible to relevant personnel for the purposes of monitoring, calibration, validation, evaluation and verification.

Any change that could affect any performance characteristic of the pasteuriser for the specified dairy material, and the reasons for it, shall be documented.

New and modified pasteurisers shall be validated before they are put into use for treating dairy material and then frequently until a record of proven calibration and reliability has been established. All validations and calibrations that were done during commissioning shall be repeated at appropriate intervals, as well as other maintenance operations and monitoring that become necessary to confirm the reliability of the pasteuriser in meeting requirements of this code.

Where monitoring, validation, evaluation, verification or calibration requires measuring instrument test equipment, such test equipment shall have appropriate accuracy and precision, and shall be calibrated before first use and thereafter at least annually. The calibration shall be traceable to a recognised national or international standard.

All checks, tests, inspections, validations, verifications, and calibrations shall be made by an appropriately trained person.

### 7.2 Design Requirements for Testing

**7.2.1** Temperature and pressure sensors shall be readily removable, while remaining functional, for testing purposes. Connecting cables, wires and/or tubes shall be long enough to allow the sensors to be moved to a point where they can be readily tested. Normally this will be satisfied if sensors can be moved to floor level.



**7.2.2** Pasteuriser control systems and sensing devices shall be able to be readily tested. To facilitate this, all sensors and control systems shall be able to be tested when the pasteuriser is operating on water under normal processing conditions.

Critical parameter displays shall be located in positions where they can be readily cross checked.

**7.2.3** The following functions shall be able to be tested: (This list is not exhaustive and other function tests may be required. Due consideration should be given to other functional requirements to eliminate possible hazards.)

7.2.3.1 Recording devices:

- temperature accuracy;
- time accuracy;
- cross check temperature indicator;
- data recording system response times;
- differential pressure accuracy or differential status record;
- flow rate monitor accuracy;
- diversion and recycle valve position;
- cross connection valves and flow rate swingbend positions;
- frequency of recording;
- frequency of scanning.

7.2.3.2 Flow diversion devices:

- valve seat leakage;
- full movement of valve stem(s);
- device correct configuration;
- manual diversion;

- divert system response time;
- time delay intervals when used;
- temperature at which flow diversion occurs;
- temperature at which forward flow resumes;
- divert valve position indicating switches;
- pasteuriser temperature sensor time constant.

#### 7.2.3.3 Flow stopping devices (e.g. pump):

- pump motor feedback (based on current transformer).

#### 7.2.3.4 Flow promoting devices (timing pumps):

- holding time in the holding tube;
- maximum processing flow rate.

#### 7.2.3.5 Differential pressure devices:

- differential pressure accuracy;
- flow recycle and forward flow differential pressure;
- operation of the pasteuriser recycle valve;
- differential pressure measurement response time.

#### 7.2.3.6 Temperature indicators:

- temperature accuracy;
- time constant;
- frequency of probe scanning.

#### 7.2.3.7 Computer controls:

- complete scan time;

- programmed safety features.

#### 7.2.3.8 Cross connections between raw and pasteurised pipelines:

- valve seat leakage;
- correct configuration.

### 7.3 Responsibilities and Reporting

For every pasteuriser, the dairy processor shall prepare a programme of validation, evaluation, monitoring, and verification, including:

- the frequency with which they will be carried out,
- the personnel responsible for carrying them out,
- the procedure for reporting to a Recognised Agency, as per NZFSA requirements relating to reporting.

### 7.4 Monitoring

#### 7.4.1 Daily Monitoring

##### 7.4.1.1 General

Daily monitoring checks and tests shall be carried out by the pasteuriser operator. Some checks and tests may be computer controlled, e.g. reducing the temperature slowly to cause a diversion, but all test outcomes shall be observed by the operator and recorded on a log sheet or acknowledged by the date and operator's signature on the graph, chart or computer-generated test report.

##### 7.4.1.2 Temperature

The reading from the temperature recorder shall be compared every day with the reading from the crosscheck temperature indicator and the readings logged. Where the temperature difference is greater than 0.5°C, the calibration of both the recorder and indicator shall be checked and adjusted or replaced when necessary.

The temperature divert setpoint shall be checked daily to ensure that it is set at the desired value. The check shall be logged and shall identify the divert setpoint value.

The temperature divert mechanism shall be test-activated each day, to confirm that it operates and to determine the diversion temperature. This may be done during the cleaning cycle or during pre-use chemical sanitation.

It is good practice to set the pasteuriser at the normal pasteurising temperature and then lower the temperature of the heating medium in 0.5°C steps of 30 seconds duration until diversion occurs.

The precise temperature of diversion shall be able to be read from the recording chart, and shall be captured by computer at the instant the signal to de-energise the divert valves is given, and displayed and checked. The screen update frequency of a computer control system is not normally high enough to enable the divert temperature to be determined precisely. Diversion shall occur when the temperature is equal to or below the temperature divert setpoint. The temperature at which diversion takes place shall not be less than the minimum pasteurisation temperature.

Note: a more rigorous test using controlled conditions, for both temperature diversion and resumption of forward flow, shall be done at least annually (see section 7.4.4, "Annual Checks").

Computer controlled systems shall have a programmed test mode that allows these tests to be performed.

Provision shall be made for examining the computer programme to confirm diversion and forward flow control is being correctly managed (refer to section 4, "Computer Control Systems" for further details).

#### 7.4.1.3 Differential pressure

A set of typical operating pressures shall be recorded daily for each differential pressure loop.

The differential pressure recycle setpoint for each differential pressure loop shall be checked daily to ensure that it is set at the desired value. The check shall be logged and shall identify the recycle setpoint values.

The differential pressure recycle mechanism shall be regularly test activated to confirm that it operates, and to determine the differential pressure at which recycle occurs.

Either

- this shall be done each day;

or

- where a pasteuriser has more than one differential pressure loop, each loop shall be tested independently on an alternating basis, e.g. where a pasteuriser has two differential pressure loops, the first loop shall be used to trigger the recycle system test one day and the second loop shall be used the following day. (This will require disabling the differential pressure loops not being tested.) This test may be carried out during the cleaning cycle or during pre-operational sanitation;

or

- the differential pressure recycle mechanism shall be test activated on an alternating basis together with the high flow divert test.

It is good practice to set the pasteuriser at the normal pasteurising pressures and then slowly decrease the pressure on the pasteurised side by 10 kPa in 30 seconds, until recycle occurs.

The precise differential pressure at which recycle occurs shall be able to be read from the recording chart, and shall be captured by computer at the instant the signal to de-energise the recycle valve is given, and displayed and checked. If differential pressure switch status is recorded in preference to differential pressure, the precise differential pressure at which recycle occurs shall be captured by computer (or recorded by the operator for non-computer controlled systems) at the instant the signal to de-energise the recycle valve is given, and displayed and checked. The screen update frequency of a computer control system is not normally high enough to enable the recycle differential pressure to be determined precisely. Recycle shall occur when the differential pressure is equal to or below the differential pressure recycle setpoint. The differential pressure at which recycle occurs shall be greater than 10 kPa.

Note: a more rigorous test using controlled conditions for both differential pressure recycle and resumption of forward flow shall be done at least 3-monthly (see sections 7.4.3, "Three-monthly checks and 7.4.4, "Annual checks").

Computer-controlled systems shall have a programmed test mode that shall allow these tests to be performed.

Provision shall be made for examining the computer programme to confirm that recycle and forward flow control is being correctly managed (refer to section 4, "Computer Control Systems" for further details).

#### 7.4.1.4 Flow

Where the pasteuriser is fitted with a flow control loop, the flow divert setpoint shall be checked daily to ensure it is set at the maximum safe flow rate or less. The check shall be logged and shall identify the divert setpoint value. The maximum safe flow rate means the flow rate at which the pasteuriser holding time will not be less than specified.

Flow diversion of the pasteuriser shall be tested.

The flow rate diversion mechanism shall be regularly test activated to confirm that it operates, and to determine the diversion flow rate. This may be carried out during the cleaning cycle or during pre-start sanitation, but not during production.

The minimum testing frequency shall be on an alternating basis with the differential pressure control loops. For example, for a pasteuriser with two pressure control loops and a flow control loop, the first pressure loop can be tested on day one, the second pressure loop on day 2, the flow loop on day 3, the first pressure loop on day 4, etc.

The test may be triggered by gradually increasing the flow rate until the pasteuriser diverts. If this is not possible (e.g. the maximum safe flow rate cannot be reached without risking damage to the equipment), the maximum safe flow rate divert setpoint may be gradually lowered until diversion occurs. Note: the maximum safe flow rate divert setpoint is a critical parameter and shall be protected; hence adjustment of this setpoint shall be via a pre-programmed test mode that cannot be entered during production.

If the flow rate is increased to perform this test, the precise flow rate of diversion shall be able to be read from the recording chart or graph, and shall be captured by computer at the instant the signal to de-energise the divert valves is given, and displayed and checked.

If the flow rate divert setpoint is lowered to perform this test, the flow rate divert setpoint shall be recorded on the recording chart or graph (see section 21.2, "Data to be Recorded"). The precise flow rate and setpoint at which diversion occurred shall be able to be read from the recording chart or graph, and shall be captured by computer at the instant the signal to de-energise the divert valves is given, and displayed and checked.

The screen update frequency of a computer control system is not normally high enough to enable the divert flow rate to be determined precisely. The flow rate at which diversion takes place shall not be more than the maximum safe flow rate.

Computer-controlled systems shall have a programmed test made that allows these tests to be performed.

Provision shall be made for examining the computer programme to confirm diversion and forward flow are being correctly managed (refer to section 4, “Computer Control Systems”).

If the pasteuriser has been programmed to recycle, rather than divert, the same tests shall apply, but shall be altered to apply to recycle rather than diversion.

#### 7.4.1.5 Records

The pasteuriser recording chart or printed trend shall be checked for completeness and accuracy by the operator responsible for the pasteuriser at the end of each shift and signed and dated.

The review of trend data signed by the operator should be checked and counter-signed by the operator’s supervisor or manager to minimise risk of failing to detect “pasteurisation alerts”.

#### 7.4.1.6 Filters

Filters shall be checked prior to each CIP unless stainless steel filters are used where the frequency of testing shall be based on historical performance (refer to section 8.11, “Filter Maintenance” for information on filter maintenance).

Records shall be kept for all filter inspections. These records shall include a description of any retained debris and the filter condition/integrity.

### 7.4.2 Temperature indicator checking and calibration

The pasteuriser temperature recording loop (which includes the temperature divert sensor), the cross check temperature indicator and, where applicable, the pasteuriser cooling outlet temperature indicator shall be checked against a reference thermometer. Where necessary the temperature indicator shall be adjusted (calibrated) to comply with the accuracy specified in this Standard, i.e.  $\pm 0.5^{\circ}\text{C}$ .

The checks and calibrations shall include the complete temperature loop (i.e. sensor, converter, indicator, recorder and wiring).

Temperature indicators that cannot be adjusted shall be replaced when they fail to meet the accuracy specified in this code.

The frequency of calibration shall be as often as is necessary to maintain the accuracy within the limits described in this code.

The frequency of calibration shall initially be monthly but can be reduced to 3-monthly following two consecutive monthly calibrations if the calibration results show that the accuracy limits are being maintained without any calibration adjustment being necessary. Where adjustment is required at a 3 monthly calibration check, subsequent frequency shall revert to monthly until stability is re-established.

The frequency of calibration can be further reduced to 6-monthly following two consecutive 3-monthly calibrations if the calibration results show that the accuracy limits are being maintained without any calibration adjustment being necessary. Where adjustment is required at a 6 monthly calibration check, subsequent frequency shall revert to monthly until stability is re-established.

In all cases the frequency of calibration shall be appropriate to the historical calibration results.

Where either the temperature indicators or the temperature recorder fail to maintain calibration at a “monthly” calibration frequency, the cause shall be investigated and remedied.

As a temporary measure, where the pasteurising temperature sensor fails to maintain calibration accuracy, the divert setpoint shall be raised by an amount sufficient to compensate for the lack of precision, until calibration checks confirm that the required accuracy is being maintained.

#### **7.4.3** Three-monthly checks

The primary divert valve and recycle valve shall be checked every 3 months to ensure they do not leak dairy material into the forward flow line when they are in the diverted or recycled position. Note: a more rigorous test of leakage across the diversion device shall be done at least annually (see section 7.4.4, “Annual checks”).

The differential pressure diversion system sensors shall be checked (and adjusted if necessary) to ensure diversion occurs when differential pressure in favour of pasteurised dairy material drops below 10 kPa.

If there are valved cross connections between pasteurised dairy material and unpasteurised dairy material (see section 3.2, “Acceptable Cross Connections”), the drain valve seat shall be checked to ensure there is no leakage of unpasteurised dairy material across the seat toward the pasteurised dairy material side of the cross connection. A pre-programmed test mode and a means of viewing leakage (e.g. a removable pipe spool or a small manual drain valve) may need to be provided to enable this check to be carried out. Note: a more rigorous



test of leakage across the cross connection shall be done at least annually (see section 7.4.4, “Annual checks”).

#### 7.4.4 Annual checks

Pasteuriser equipment shall be checked at least annually by competent technical personnel, usually after winter maintenance.

These checks shall include (as applicable to the type of heat treatment equipment):

1. Visually checking for corrosion, holes, cracks and defects, all areas of equipment where dairy material may be contaminated by micro-organisms or chemicals (e.g. steam, heating water, cooling water, cleaning solutions, and other milk products, especially unpasteurised milk and cream) via defects in the equipment materials.
  - This shall include welds and potential corrosion or cracking sites (e.g. in plate heat exchanger plates) in all product contact surfaces, and surfaces from which contamination may drain, drop or be drawn into the dairy material. Where possible, the corresponding opposite surface through the material shall also be checked.
  - Where visual inspection for defects is impossible (e.g. inside the tube side of shell and tube heat exchangers, inside the jackets of jacketed vessels, and between the wall and the insulation of tanks and silos), other non-destructive testing and checking methods may be used (e.g. dye penetration testing to AS 2062:1997, “Non-destructive testing – Penetrant testing of products and components”, electrolytic solution penetration or the ultrasound method).
2. Visual inspection that plate heat exchanger plate gaskets are not leaking.
3. The safety of freezing point depressants and anti-corrosion additives.
4. The maximum flow rate for the specified dairy material.
5. The minimum holding time, either calculated from maximum flow rate and holding tube dimensions or checked by direct measurement with suitable equipment.
6. That diversion occurs while the temperature is equal to or below the diversion setpoint.
7. That diversion occurs while the flow rate is equal to or above the flow rate diversion setpoint.
8. Timing of primary and secondary divert valve diversion and return to forward flow.

- 
9. That the secondary divert valve does not leak dairy material into the forward line when in the diverted position. A pre-programmed test mode, and a means of viewing leakage (e.g. a removable pipe spool, or a small manual drain valve) may be needed to enable this check to be carried out.
  10. That any cross connections achieve the block-bleed-block requirements with leakage away from the pasteurised product valve.
  11. A direct measurement of the pasteurising temperature sensor and cross check temperature indicator time constants.
  12. Measurement of the temperature diversion system response time.
  13. That resumption of forward flow occurs only at a temperature above the pasteurising temperature diversion setpoint and with sufficient delay.
  14. That resumption of forward flow occurs only at a flow rate not above the maximum flow rate allowable and with sufficient delay.
  15. That recycle occurs when the differential pressure is equal to or below the differential pressure recycle setpoint and that resumption of forward flow does not occur until the differential pressure is greater than the differential pressure recycle setpoint and with sufficient delay.
  16. That the differential pressure devices meet the required accuracy.
  17. Direct measurement of the differential pressure sensor response time.
  18. Direct measurement of the recycle valve response time.
  19. Measurement of the recycle system response time.
  20. The recording system for the pasteurisation temperature, final product cooling temperature, differential pressure or differential pressure status, cross connection status and flow rate where used.
  21. That the system records all diversion and recycle events.
  22. Data record accuracy.
  23. Data recorder time accuracy and synchronisation between record of temperature and divert events.
  24. Synchronisation between records of flow rate, differential pressure or differential pressure status and recycle events.

---

25. A check of the computer programme for changes and where changes have been made, a check that they:

- have been authorised and recorded;
- do not compromise product safety;
- have been made correctly.

#### 7.4.5 Direct measurement of the minimum holding time

The pasteuriser minimum holding time shall be checked by direct measurement with suitable equipment:

- before routine pasteurisation can commence for a new pasteuriser;
- after any change that may alter the configuration or that may affect the flow rate or volume of the holding section, such as:
  - alteration or replacement of any permanent parts of the holding tube (excluding gaskets and seals);
  - replacement or modification of any pumps;
  - replacement or modification of any flow controller;
  - any downstream alterations;
  - any other modification or event which may affect the holding time;
- at intervals of not more than 5 years, for unmodified plants.

The results of this check shall be used to determine the minimum pasteurising temperature and re-set, if necessary, the diversion temperature setpoint and the operating temperature.

#### 7.4.6 Crack testing of plate heat exchangers

Plate heat exchangers shall be tested at least every 3 years using an industry-accepted non-destructive method, e.g. dye-penetrant testing to AS 2062:1997, “Non-destructive testing – Penetrant testing of products and components”, electrolytic solution penetration, ultrasound method or helium tests.

## 7.5 Pasteuriser Evaluation and Verification

Any pasteuriser that is:

- new,
- relocated,
- or has undergone a significant change

shall be validated (internally or externally), and then evaluated for compliance with the requirements of this code and other regulatory requirements.

Finished product manufactured from dairy material heat treated during the period between commissioning and the independent evaluation of the pasteurising equipment, including the resolution of any critical non-compliances, shall be isolated, appropriately labelled and secured against use, sale, or export, and managed as non-conforming dairy material (refer section 2.2) in accordance with NZFSA requirements relating to non-conforming dairy material.

All pasteurisers operated in accordance with this code shall be externally verified in conjunction with the routine external verification of the RMP under which they are operated.

## 8 General Design of Batch Pasteurisers

### 8.1 The Batch Pasteurisation Process

8.1.1 The batch pasteuriser consists of a jacketed vat in which one of the following operations is carried out:

- The dairy material is heated in the vat to the desired temperature (by means of hot water or steam sprayed on to the sides of the vat or circulated around a double jacket or circulated by means of heating coils surrounding the inner jacket). The dairy material shall be agitated throughout the heating and holding periods.
- The dairy material may be partially heated by an external heat source and raised to the final pasteurisation temperature in the vat where it is held for the required holding time.
- The dairy material may be heated to the pasteurisation temperature in an external heat source before entering the vat where it is held for the required holding time.
- The dairy material may circulate from the vat through an external heat source, where it is brought up to pasteurisation temperature. The dairy material may continue to circulate through the external heat source throughout the holding period to ensure the vat temperature does not drop below the pasteurisation temperature.

8.1.2 In any of the above methods, after the required holding time the dairy material may be partially cooled in the vat, or cooled by disconnecting the heating medium and connecting cooling or chilling water to the heat exchanger, or may be withdrawn from the vat at the pasteurising temperature.

### 8.2 Heat Treatment to Achieve Pasteurisation

The heat treatment delivered by a batch pasteurisation system shall comply with section 11.2, of this code. Where the designated heat treatment step is a batch pasteuriser, the equipment used shall comply with this code.

Different time/temperature pasteurisation combinations may be used for different product specifications provided they meet the requirements of section 11.2.

---

### **8.3 General Requirements for Batch Pasteurisers**

**8.3.1** Where an external heat exchanger is used for heating or cooling, product contact equipment external to the vat shall be minimised, and shall only include the circulating pump, heat exchanger, connecting pipe-work and essential valves.

**8.3.2** Cooling and chilling water supplies shall be physically disconnected (or separated by a vented air space) from the heat exchanger during the heating and holding cycles.

**8.3.3** Where vat heating is used, the entire heat transfer surface area shall perform the heating duty. The vat shall not have separate sections that are only used for cooling and chilling.

**8.3.4** Where an external heat exchanger is used for cooling, the cooling medium shall either be potable, or the pasteurised dairy material shall be maintained at a pressure of no less than 10 kPa above the cooling medium at all times. If pressure is lost, the dairy material batch shall be repasteurised. Pressure shall be monitored and recorded. Sensors and recording devices shall comply with the requirements for differential recording devices laid out in section 10.3, "Differential Pressure Monitoring" of this code.

**8.3.5** Differential pressures are not required and do not need to be monitored in systems that have been engineered to guarantee that at all times (including equipment failure and fatigue), pasteurised milk cannot become contaminated with non-potable cooling medium.

This result can be achieved, for example, by using air gap plates that have leak escape passages between the plates, separating pasteurised dairy material from non-potable cooling medium in the heat exchanger. Where this option is employed, leak escape channels shall open to the atmosphere and shall be able to be readily and routinely checked for signs of leakage. Where leakage is detected, the affected plates shall be replaced as soon as practicable.

**8.3.6** The dairy material shall be filtered or centrifuged to remove particulate matter that can protect micro-organisms against the specified heat treatment before the heating cycle commences.

Filters shall have a maximum pore size of 200 µm, 500 µm, or 1000 µm in order to meet the respective maximum particle size limits described in section 2.4 and Diagram: Air Space Heating below.

**8.3.7** Filters shall have a maximum pore size of 200 µm, 500 µm, or 1000 µm in order to meet the respective maximum particle size limits described in Section 2.4 and Table below. Where a centrifuge is used the time temperature requirements specified for a 200 µm filter shall apply.

#### **8.4 Height and Placement of the Vat**

The batch pasteuriser may be mounted on a slab or island, or on adjustable legs. These legs shall be smooth with rounded ends and shall have no exposed threads. Where the legs are made of hollow stock they should be sealed, and shall in all cases be of such length to provide sufficient clearance between the floor and the bottom of the pasteuriser to allow for easy cleaning and inspection.

#### **8.5 Heating Jacket**

The heating jacket or vat insulation shall extend above the dairy material liquid level. If the vat is not jacketed, then it shall be fully insulated. Where a heating jacket or heating coil is used, the heating medium shall remain at or above the pasteurising temperature throughout the holding period.

#### **8.6 Agitation**

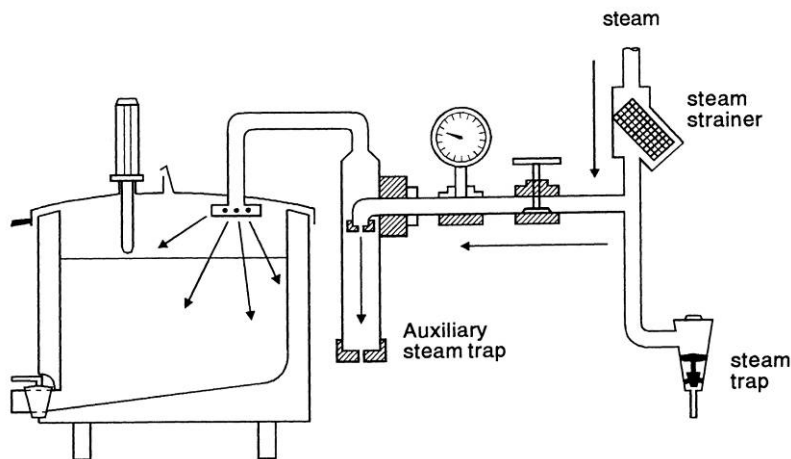
The method of agitation shall be such that the temperature difference between the dairy material in the warmest section and the coolest section of the vat shall not exceed 0.5°C at any time during the holding period.

The vessel shall be designed to provide adequate agitation throughout the vessel and to ensure that dairy material splashed on to walls, agitator shafts and paddles, and other internal surfaces receives the full heat treatment.

## 8.7 Air Space Heating

**8.7.1** Tests have shown that when foam is present on the top of dairy material in vats, or in pockets of the vessel during pasteurisation, the temperature of the foam may be well below the pasteurisation temperature because it acts as an insulator. In such cases, if pathogenic organisms are in the foam they will not be killed. Some foam is present at some time, in all vats, particularly in certain times of the season. Furthermore, during filling, dairy material is frequently splashed on to the surface and fixtures of the vat above the liquid level, as well as on to the underside of the vat cover. Droplets of this unpasteurised splashed dairy material then fall back into the body of the dairy material and can be a source of contamination.

### Diagram: Air Space Heating





**8.7.2** The walls of the holding vessel and the agitator stem above the dairy material level shall be at or above pasteurising temperature.

**8.7.3** Each vat shall be provided with a means of heating the air space above the dairy material to at least 3°C higher than the minimum pasteurising temperature during the entire holding period (see Diagram “Air Space Heating”).

**8.7.4** When a vat is used exclusively for the pasteurisation of dairy materials at an elevated temperature above the minimum pasteurisation temperature, producing an air space temperature of 3°C or more above the minimum pasteurisation temperature, the air space heater is not required.

**8.7.5** A temperature indicator shall be fitted to measure the temperature of the air space.

## **8.8 Covers**

**8.8.1** Covers shall be constructed so as to prevent the entry of contamination, including liquids on the outside of the cover.

**8.8.2** All batch pasteurisers shall have covers which can be opened and maintained in an open position, are sufficiently rigid to prevent buckling, are self-draining in the closed position and are provided with adequate, conveniently located and durable handles of hygienic design which are either welded in place or formed into the cover materials. Proper welding will create sufficient radii at the point where the handle meets the outside of the cover. The handles shall not protrude inside the cover.

**8.8.3** The covers shall have downward flanges at least 10 mm long along the edges and be close fitting. The design shall be such that when raising the cover, any liquid on the top will not enter the pasteuriser, and when the cover is in its fully open position, the drops of condensate formed on the underside of the cover will not drain into the pasteuriser. To further protect the contents, all openings shall have either permanently attached hygienic pipeline fittings, or shall be flanged upward at least 10 mm and covered.

**8.8.4** A minimum diameter of 25 mm is normally used for agitator shaft openings for removable agitators. For the non-removable type agitators, there shall be sufficient clearance to provide a 25 mm minimum annular cleaning space between the agitator shaft

and the inside surface of the flanged opening. In all cases, a drip shield shall be fitted on the agitator shaft that can be easily and readily dismantled to permit cleaning of its entire surface. This is necessary to protect against the entrance of contaminants into the pasteuriser through the space around the agitator shaft.

**8.8.5** There shall be condensation-diverting aprons, as close to the vat as possible, on all pipes, thermometers, and other equipment extending into the vat, unless a water-tight joint is used.

**8.8.6** The covers shall be kept closed during operation.

## **8.9 Fittings**

**8.9.1** All internal angles of 135° or less should have radii of not less than 6 mm to facilitate proper cleaning.

**8.9.2** There shall not be threads in the dairy material zone, unless it is possible to create a tight enough bond to prevent the entrance of dairy material into the threaded area. (Even if threaded sections can be taken apart for manual cleaning, threads are not acceptable because of the difficulty of cleaning.)

**8.9.3** Spring clips or pins that are easy to remove may be used in lieu of threads.

**8.9.4** Connections and/or openings for indicating, recording and air space thermometers should be located either in the top enclosure cover, or through the side wall. Thermometer wells shall be removable and hygienically mounted on to the vessel. Temperature and pressure sensors shall meet the requirements of sections 5.2, "Data Sensing" and 7.2.1 of this code.

## **8.10 External Heating**

Where an external heat exchanger is used:

either

- the dairy material shall continue to circulate through the heat exchanger throughout the holding period with the heating medium remaining at or above pasteurising temperature.

The whole heat exchanger shall be used for the heating duty and cooling, and the chilling medium supply shall be disconnected through the heating and holding stages;

or

- the heat exchanger shall be shut off from the holding vessel at both the exit and return points of the heat exchanger or of the vessel. A positive break shall be established by either physically disconnecting the lines or by providing a vented air space between the two. The holding time shall not commence until the valves have been shut. The same heat exchanger shall not be used for cooling the pasteurised dairy material after the holding time unless it has received an equivalent heat treatment or has been cleaned and sanitised.

## **8.11 Filter Maintenance**

**8.11.1** Non stainless steel filters shall be inspected prior to each CIP and:

- reusable filter bags shall be cleaned, or replaced if damaged;
- single use filter bags shall be replaced.

Some filter bags are supplied and identified as “single use” items. Filter bags will fail if they are used beyond their design capability.

Stainless steel filters shall be checked at a frequency based on historical performance.

**8.11.2** The RMP shall have written procedures for dealing with split filter bags. The procedures shall specify additional control measures for the suspect dairy materials.

Whenever an inspection of any filter reveals that the filter bag has failed due to splitting, the operator shall record the event and notify the supervisor or appropriate authority of this event.

The supervisor or appropriate authority shall implement the site procedures for dealing with split filter bags, described in the RMP.

---

## 9 Prevention of Mixing of Raw and Pasteurised Product

### 9.1 Requirements

**9.1.1** There shall be a method of ensuring that the outlet valve for pasteurised product is closed before filling of the holding vessel can commence. This ensures that no unpasteurised product passes forward from the batch tank prior to pasteurisation.

**9.1.2** The raw product line shall be totally separate from the pasteurised product line. Where cross connections are required between the raw and pasteurised produce lines for CIP purposes, measures shall be taken to prevent cross contamination occurring. Cross connections shall comply with section 3.2.1 of this Code.

**9.1.3** When the pasteuriser is in heating-holding mode, there shall be no leakage past the outlet valve (refer to section 9.2).

**9.1.4** The inlet line shall be removed from the holding vessel or otherwise disconnected. This is to ensure that leakage of raw product into the holding vessel cannot occur after heat treatment commences.

Note: this includes valve leakage, thermal expansion resulting in overflow, etc.

**9.1.5** The inlet line disconnection point shall be as close as practicable (but not more than two pipe diameters) from the holding vessel. The line shall be free draining to the holding vessel.

---

## 9.2 Valve Design

**9.2.1** Inlet and outlet valves should be leak-detection type designed to prevent leakage past the seat in the closed position. Installations not equipped with leak-detection inlet valves shall have piping that is arranged so that only one vat can be used. Only one vat shall be connected to the inlet line at one time, during the filling time. The inlet line shall be disconnected during holding and emptying periods.

**9.2.2** Where plug valves are fitted, all leak-detection grooves shall be at least 5 mm wide and at least 3 mm deep at the centre to prevent clogging. Mating grooves may be necessary to provide these dimensions throughout their combined lengths when the valve is in, or almost in, the fully closed position. All single leak grooves and all mating leak grooves, when mated, shall extend through the entire depth of the seat so as to divert leakage and to prevent air binding. Washers and other parts shall not obstruct leak-detection grooves.

**9.2.3** In plug valves, stops shall be provided and shall be designed so that the plug will be irreversible unless duplicate, diametrically opposite grooves are also provided. Stops shall be designed so that the operator cannot turn the valve beyond the stop position, either by raising the plug or by any other means.

## 9.3 Inlet Design

**9.3.1** Inlet valves shall be closed during holding and emptying periods.

**9.3.2** When the inlet line enters the vat above the product level and is submerged in the product during filling of the vat, and does not form part of a product recirculation circuit during the holding period, the inlet line shall be removed from the vat or raised above the product level before the holding time commences.

**9.3.3** Inlet valves shall not be located in the vertical pipeline, unless they can be installed so that the system is totally self-draining.

**9.3.4** The pipeline between the inlet valve and the vat shall slope to assure free drainage to the vat.

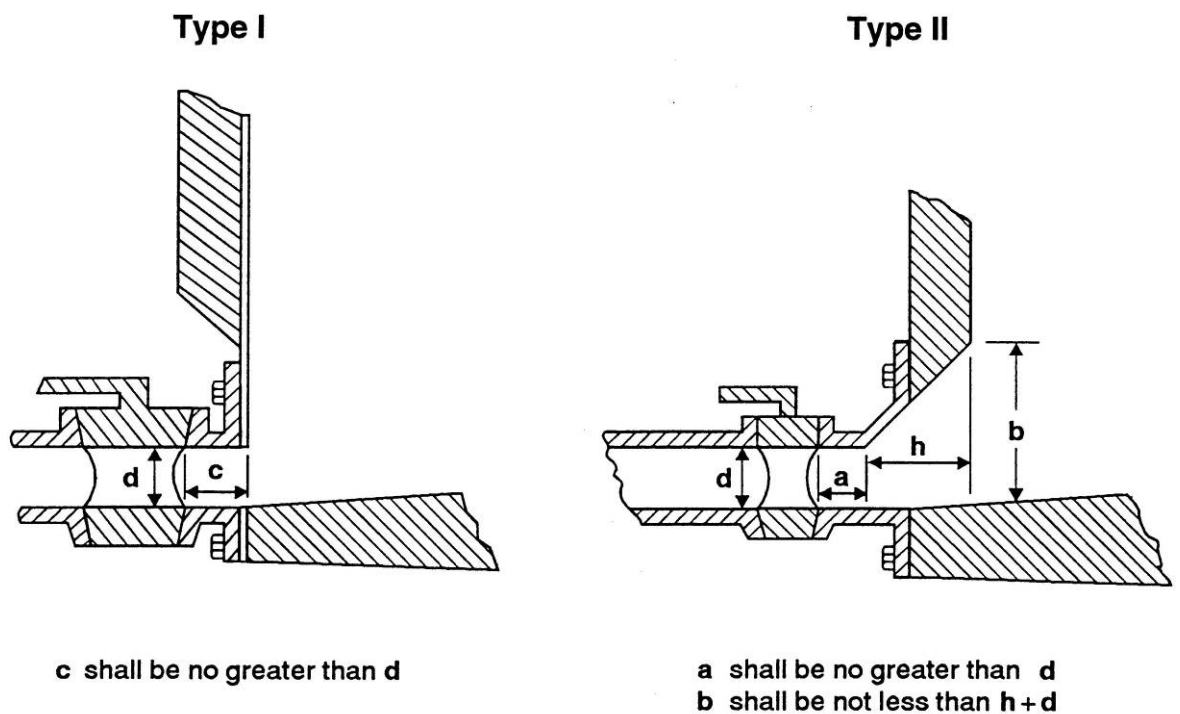
**9.3.5** Inlet connections, other than close-coupled valves, shall not enter the pasteuriser below the level of the product.

#### **9.4 Outlet Design**

**9.4.1** Outlet valves shall be closed during filling, heating and holding.

**9.4.2** The outlet valve shall be designed so as to prevent the accumulation of unpasteurised product in the product passage of the valve when in the closed position.

**9.4.3** The outlet valve shall be close-coupled. If the valve is not close-coupled to the vat, there will be a certain amount of product between the valve body and the inner wall of the vat that will not be properly heated during the pasteurisation process.



**Diagram: Close-Coupled Outlet Valves**

**9.4.4** A close-coupled valve is one in which the seat is either flush with the inner wall of the pasteuriser or closely coupled so that no product in the valve inlet is more than 0.5°C colder than the product in the centre of the pasteuriser at any time during the holding time (see diagram in 9.4.3, Type I).

**9.4.5** A close-coupled valve which is not truly flush (see diagram in 9.4.3, Type II) is considered to be satisfying this requirement when:

- the vat outlet is flared so that the smallest diameter of the large end of the flare is not less than the diameter of the outlet line plus the depth of the flare; and
- the greatest distance from the valve seat to the small end of the flare is no greater than the diameter of the outlet line; and
- the outlet and the agitator are placed so product currents will be swept into the outlet.

---

## 10 Control Systems

### 10.1 Requirements for Pasteurisation

The temperature of dairy material in the vat and, if circulated, the dairy material in connecting pipework and heat exchangers shall not be less than the required pasteurisation temperature during the whole holding period to ensure the dairy material is fully pasteurised (refer to section 2, “Heat Treatment to Achieve Pasteurisation”, of this document for minimum holding time-temperature combinations).

The temperature of air space above the dairy material in batch pasteurising vats shall be heated to be at least 3°C above the minimum pasteuriser holding temperature to ensure that foam on top of the dairy material and dairy material splashes on the internal surfaces of the vat receive a full pasteurising heat treatment (refer to section 8.7, “Air Space Heating”).

Where the dairy material temperature or air space temperature is observed to drop below the specified minimum before the required holding time has been exceeded, the pasteurisation is deemed to have failed. The dairy material and air space temperatures shall be raised to above the minimum and the holding time measurement started again. No allowance can be made for any partial heat treatment already received.

### 10.2 Temperature Monitoring System

#### 10.2.1 Temperature indicators

Refer to section 5, “Data Collection and Recording System”, for the location, resolution, performance and calibration requirements for temperature indicators.

#### 10.2.2 Temperatures to be monitored and recorded

##### 10.2.2.1 Dairy material temperature

The temperature of the dairy material shall be measured and recorded continuously during the heat treatment period (refer to section 10.4.1).

In addition to the pasteurising temperature recorder, there shall be a separate cross check temperature indicator. The reading from the temperature recorder shall be compared daily with the reading from the cross check temperature indicator and the readings logged. Where



the temperature difference is greater than allowed in section 7.4.1.2, the calibration of both the recorder and the indicator shall be checked and adjusted or the instruments replaced when necessary.

#### 10.2.2.2 Air space temperature

A temperature indicator shall be fitted to indicate the air space temperature each time the pasteuriser is in operation.

This temperature indicator reading shall be observed and checked against the minimum required air space temperature and the value recorded during the pasteuriser holding cycle for each batch of dairy material treated. The temperature may be logged manually, or alternatively a temperature recorder may be installed and the temperature continuously recorded.

#### 10.2.2.3 Cold dairy material temperature

Where the dairy material passes through the heat exchanger cooling system without being recirculated to the pasteuriser vat there shall be a cold dairy material temperature indicator if the outlet temperature is critical to product safety.

### 10.2.3 Position of temperature sensors

The temperature sensor for the pasteurising temperature recording system and the temperature sensor for the cross check temperature indicator shall be positioned in the vat to measure a representative temperature of the dairy material in the vat, e.g. where the vat is fitted with a heating jacket, the sensor fittings shall be designed to eliminate any direct thermal influence from the heating medium within the jacket.

The indicating and recording sensors shall be positioned as close as possible to each other.

The air space temperature sensor shall be positioned to measure a representative temperature of the air space above the dairy material. To achieve this, the bottom of the sensor shall be at least 25 mm above the surface of the dairy material and shall be at least 25% of the tank diameter away from the air space heating source.

### **10.3 Differential Pressure Monitoring**

#### **10.3.1 Differential pressures to be monitored and recorded**

Where an external heat exchanger is used and the cooling medium is not of potable standard, the pasteurised dairy material shall be maintained at a pressure of no less than 10 kPa above the cooling medium at all times.

These pressures shall be monitored and recorded continuously during the operation of the pasteuriser (refer to section 10.4.1).

A set of typical operating pressures shall be recorded daily for each differential pressure loop.

If the pressure safety system detects a low pressure failure while the vat is in operation the circulation system shall automatically shut down and lock out until manually reset.

The activation of this pressure safety system shall be recorded and the system not restarted until the cause of the fault has been located and rectified.

#### **10.3.2 Pressure measurement and control**

Where pressure differential monitoring and control is required, the differential control system shall comply with section 5, "Data Collection and Recording System" of this Code.

The testing of pressure differential equipment shall comply with section 7, "Testing and Calibration" of this Code.

### **10.4 Data Recording System**

**10.4.1** Each vat shall be equipped with a data recording system to record the dairy material temperature and where required the heat exchanger differential pressure (refer to section 10.2).

**10.4.2** The data recording system shall comply with the scale, ranges, resolution requirements and chart printing requirements contained in section 5 "Data Collection and Recording System" of this Code.

**10.4.3** When the dairy material is heated to pasteurisation temperature in the vat and is partially cooled before opening the outlet valve, the recording system shall show at least the minimum holding time at the minimum pasteurisation temperature.

**10.4.4** When the dairy material is preheated to pasteurisation temperature before entering the vat, the recording system shall show the required holding time, plus the time of filling the vat from the level of the temperature sensor. When cooling is begun after the outlet valve is opened, or occurs entirely outside the vat, the recording system shall show the required holding time, plus the time necessary to empty the vat to the level of the temperature sensor.

The filling time and emptying time for each vat shall be recorded initially and after any change which may affect these times.

**10.4.5** On a frequency of by batch or daily, the following information shall be recorded:

- the name of the plant;
- the number and location of the batch pasteuriser and/or recorder when more than one is used;
- the date;
- the batch number;
- the amount and name of dairy material represented by each batch or run on the chart;
- the dairy material temperature over the holding period;
- the heat exchanger pressure differential or differential pressure switch status throughout the cooling cycle (when the pressure differential is monitored);
- the holding time, including filling and emptying time, when required;
- the temperature of the air space during the operation of the pasteuriser;
- any unusual occurrences;
- the signature of the operator.

## **10.5 Calibration**

All temperature and pressure indicators and recorders shall be calibrated according to the requirements in section 7, "Testing and Calibration".

---

# 11 HTST Pasteurising Systems

## 11.1 Components of HTST Pasteurising Systems

All HTST pasteurising systems shall include the following items of equipment:

- a raw product balance tank;
- a heat exchanger;
- a filter or centrifuge (where not incorporated elsewhere upstream from the pasteuriser);
- a timing pump and flow rate control or flow rate limiter;
- a holding tube;
- a temperature diversion system;
- either a differential pressure system or a failsafe system
- a data recording system.

HTST pasteurising systems may also include:

- a raw product pump;
- an intermediate balance tank.

## 11.2 Heat Treatment to Achieve Pasteurisation

The heat treatment delivered by an HTST pasteurisation system shall comply with section 2, “Heat Treatment to Achieve Pasteurisation” of this code. Where the designated heat treatment step is an HTST pasteuriser, the equipment used shall comply with this code.

Different time/temperature pasteurisation combinations may be used for different product specifications provided they meet the requirements of section 2, “Heat Treatment to Achieve Pasteurisation”.

---

## 12 Raw Product Balance Tank

### 12.1 Purpose

A raw product balance tank is required to:

- assist in maintaining constant flow conditions through the pasteuriser;
- assist with the maintenance of differential pressures;
- provide a break point and an escape path to drain between the raw product silos and the pasteuriser, to prevent raw product flooding by gravity from the silos into the pasteuriser in the event of equipment failure;
- and may also provide a return point for product returned from the divert and recycle valves.

### 12.2 Requirements

The raw product balance tank shall:

- incorporate a device for automatic control of raw product to a near constant level so that product is delivered at a constant flow rate with minimum air entrainment;
- be free draining;
- have a removable cover or hinged lid or hatch that prevents the entry of extraneous material into the tank. Inlets shall not hinder the removal or replacement of the balance tank cover;
- have the raw product inlet at a lower level than the minimum operating liquid level to prevent the incorporation of air into the product;
- have other inlets into the tank terminating:

either

- at least two pipe diameters above the overflow level so that they shall freely drain after use (e.g. from the flow diversion line) and to provide an air gap safety break between the pasteurised and raw product sides of the pasteuriser (the tank will normally be fitted with an overflow to limit the maximum product level);

or

- for products that are froth sensitive, the lines may finish below the liquid level if they are fitted with a siphon breaker;
- have inlets constructed so that extraneous material cannot enter the tank;
- be of a design and capacity that prevents air being drawn into the pasteuriser with the product;
- be designed to minimise the formation of froth when product is returned to the tank.

The tank should typically have an average residence time of less than 5 minutes to assist with recovery from diversion and to prevent excessive bacterial growth.

The tank overflow lines shall be able to be cleaned and inspected.

## 13 Raw Product Pump

### 13.1 Purpose

The raw product pump is used to pump product from the raw product balance tank to the heat exchanger. It may be possible to design a system where a raw product pump is not required.

The raw product pump's function is to prime the pasteuriser on start-up and to ensure that there is sufficient delivery pressure to the timing pump for the system to operate, and in some systems to boost the flow rate during CIP.

### 13.2 Requirements

**13.2.1** The pump shall be sized and controlled so that the correct differential pressures in the regeneration cooling and chilling sections of the pasteuriser are maintained during pasteurisation (refer to section 16.1, "General").

**13.2.2** The pump may stop if a divert valve fault occurs as described in section 17.1.6, section 19.2.7, "Timing of valve switching to divert position" and section 19.3.6, "Timing of valve returning to forward flow position".



---

## 14 Heat Exchanger

### 14.1 Purpose

The function of the heat exchanger is to heat the dairy material to the pasteurising temperature and, after the holding period, to cool it down to a specified temperature.

### 14.2 Design

**14.2.1** The heat exchanger may be a plate type or a tubular type.

**14.2.2** The heat exchanger may incorporate one or more regeneration sections for transfer of heat between the hot pasteurised product and the incoming cold raw product.

**14.2.3** The system may incorporate one or more cooling or chilling sections.

**14.2.4** The heat exchanger may incorporate direct steam injection for raising the raw product temperature. Direct steam injection units shall have a means of preventing back-flow of product into the steam line. The direct steam injection unit shall be cleanable back to the back-flow prevention device.

### 14.3 Heating and Cooling Mechanisms

**14.3.1** Steam, hot water, potable cooling water and non-potable water shall only use food-grade treatment chemicals. Water that may come in contact with product shall be of potable standard and steam shall be of culinary standard.

**14.3.2** Only non-toxic and non-tainting boiler water additives shall be used in product contact steam.

**14.3.3** Further requirements for product contact steam can be found in:

3-A, "Accepted Practices for a Method of Producing Steam of Culinary Quality", No. 609-02, 1996.

#### **14.4 Leak Escape**

A leak detection groove in the heat exchanger gasket, open to the atmosphere at both ends, shall be provided to allow leakage past the gaskets to drain to waste. The grooves prevent liquid in between plates leaking into the flow channels at the corners of the plate.

#### **14.5 Operating Differential Pressures for Non-Potable Systems**

The heat exchanger shall be designed to ensure that no contamination of pasteurised dairy material by unpasteurised dairy material, or non-potable media can occur. This shall be achieved by maintaining the operating pressure on the pasteurised product side of the regeneration section higher than on the raw product side and by maintaining the operating pressure on the product side of the chilling or non-potable cooling section higher than on the non-potable water side or by providing a leak escape channel between the opposing streams (refer to section 20.1.4).

#### **14.6 Inspection Requirements**

The heat exchanger shall be constructed so that it can be dismantled for inspection of product contact surfaces. Sufficient space should be left on plate pasteuriser frames to allow plates to be readily separated and viewed.

## 15 Intermediate Balance Tank

### 15.1 Purpose

An intermediate balance tank may be used to assist in maintaining pressure differentials across the heat exchanger, particularly when separators are included in the pasteurisation circuit.

### 15.2 Requirements

**15.2.1** The tank shall comply with all requirements of section 12, “Raw Product Balance Tank”.

**15.2.2** When located upstream from the holding tube, the flow rate control mechanism for the pasteuriser shall be located after the intermediate balance tank so that the flow rate measured is representative of the flow through the holding tube.

**15.2.3** When located downstream from the holding tube, the tank shall be in a critical hygiene area.

## 16 Filter or Centrifuge

### 16.1 General

When the product has not been previously filtered or centrifuged to remove particulate matter which can protect micro-organisms against the specified heat treatment, a pasteuriser shall have a filter or centrifuge located before the final heating section.

Filters shall have a maximum pore size of 200 µm, 500 µm, or 1000 µm in order to meet the respective maximum particle size limits described in section 2 and the table in 2.4.4 of this code.

### 16.2 Equivalent Pore Size for Centrifuges

Where a centrifuge is used the time temperature requirements specified for a 200 µm filter shall apply.

### 16.3 Filter Maintenance

**16.3.1** Non stainless steel filters shall be inspected prior to each CIP:

- reusable filter bags shall be cleaned, or replaced if damaged;
- single use filter bags shall be replaced

Some filter bags are supplied and identified as “single use” items. Filter bags will fail if they are used beyond their design capability.

Stainless steel filters shall be checked at a frequency based on historical performance.

Records shall be kept for all filter inspections. These records shall include a description of any retained debris and the filter condition/integrity.

**16.3.2** The RMP shall have written procedures for dealing with split filter bags. The procedures shall specify additional control measures for the suspect products.

Whenever an inspection of any filter reveals that the filter bag has failed due to splitting, the pasteuriser operator shall record the event and notify the supervisor or appropriate authority of this event.

The supervisor or an appropriate authority shall implement the site procedures for dealing with split filter bags, described in the site product safety programme.

**16.3.3** A system of interchanging filters should be put in place to allow the change-over of filters during production runs.

---

# 17 Timing Pumps and Other Flow Rate Control Systems

## 17.1 General

17.1.1 The function of the timing pump is to ensure that:

- the flow rate of dairy material through the holding section does not exceed the design flow rate;
- in conjunction with the back-pressure inducing device, the differential pressures specified in section 20.2, "Differential Pressure Control" are maintained.

17.1.2 Where a flow controller is fitted, flow should be controlled to within  $\pm 5\%$  of the setpoint and in all cases the dairy material shall be held for the required minimum holding time.

17.1.3 A flow control or flow limiting device shall be required if the flow through the holding tube could increase to an extent that the holding time falls below the minimum.

17.1.4 Where in-line flow limiters are used, adequate provision shall be made during cleaning to allow sufficiently high cleaning velocities to be attained. In such cases, provision shall also be made to ensure that, during pasteurisation, the design flow rate is not exceeded.

17.1.5 In some pasteurisers the timing pump is also the raw product pump.

17.1.6 The pump may be required to stop if a divert valve fault occurs (refer to sections 13.2.2, 19.2.7, "Timing of valve switching to divert position" and 19.3.6, "Timing of valve returning to forward flow position").

## 17.2 Location

**17.2.1** The timing pump shall be located downstream from the final raw product regeneration section, where regeneration is used, and upstream from the inlet to the holding tube. The flow control device shall operate in both forward flow and divert configurations.

**17.2.2** The timing pump location may be varied in pasteurisers that do not have product- to-product regeneration or are fitted with air gap-type plates (refer to section 20.1.4).

**17.2.3** The flow rate measuring device shall be positioned so that it accurately measures the flow rate in the holding tube at all times, i.e. during both diversion and forward flow modes. Where a flow rate limiting device is used, it shall be positioned so that it can accurately limit the maximum flow rate through the holding tube.

**17.2.4** When an intermediate balance tank is used the timing pump location shall meet the requirements of section 15.2.2.

## 17.3 Types of Pump

The timing pump shall be:

- a centrifugal pump in conjunction with an unpowered self operating mechanical flow limiting device of fixed flow rate; or
- a centrifugal pump incorporating an automatic flow rate control system using a sanitary flow meter to control a variable speed motor or a modulating control valve; or
- a positive displacement pump of one of the following types:
  - a piston-action pump driven at a fixed speed,
  - a rotary lobe pump with rotors driven at a fixed speed; or
- any other system which is linked to an automatic flow rate control system consisting of a sanitary flow meter and variable speed motor or a modulating control valve.

#### 17.4 Flow Rate Monitor

In a system incorporating a timing pump with an automatic flow rate control system, where it is possible to exceed the designated maximum flow rate, the system shall include a device, or devices, that:

- continuously records and displays the flow rate of the dairy material being pasteurised,
- activates the high flow rate protection system if the designated maximum flow rate is exceeded;
- activates the high flow rate protection system if there is no signal from the flow rate monitor.

#### 17.5 Flow Rate Accuracy

Measurement and recording of the flow rate shall be accurate to within  $\pm 5\%$  at the maximum flow rate.

#### 17.6 Flow Rate Confirmation

The maximum system flow rate shall be able to be measured (refer to section 18.3.3, "For flow rate determination").

#### 17.7 Protection Systems for High Flow Rates

If the flow rate exceeds the maximum safe flow rate, the effect on the pasteuriser holding time will be immediate, i.e. the holding time may immediately fall below the minimum safe holding time, causing unpasteurised dairy material to go forward. Similarly, if the signal is lost from the flow rate monitor, the maximum safe flow rate may have been exceeded and the holding time may have immediately fallen below the minimum safe holding time, causing unpasteurised dairy material to go forward.

To overcome this one of the following methods shall be applied:

either

- the high flow rate protection system shall activate the recycle valve (a mask on the high flow rate protection activation during a temperature divert is acceptable);

or



- where the high flow rate protection system activates the diversion device, the divert temperature setpoint shall be set at a safety margin in excess of the temperature required to achieve adequate pasteurisation at all possible higher flow rates. For example, raising the temperature divert setpoint from 72.0 °C to 72.1 °C provides sufficient safety margin for a flow rate increase of up to 20% (with a 15 second holding time system).

Note: when the holding tube has sufficient length to provide adequate holding time for all possible flow rates the high flow rate protection systems described in this section are not necessary.

The additional holding time required is dependent on the response time of the control equipment and the diversion device (this is usually 5 seconds but may be longer for larger valves).

#### **17.8 Return to Forward Flow Position**

Following activation of the high flow rate protection system, return to forward flow shall only resume once the following conditions have been satisfied:

- When the recycle valve has been activated as part of the high flow rate protection system, return to forward flow shall only resume once the flow rate is less than the flow rate diversion setpoint, followed by a delay of at least the minimum required holding time, and all parts of the pasteurised dairy material sections of the heat exchanger and pipework up to the recycle valve have been effectively heat treated or cleaned and sanitised, as described in section 20.2.4, “Resumption of forward flow after differential pressure failure” of this code.
- When the diversion device has been activated as part of the high flow rate protection system, return to forward flow shall only resume once the flow rate is less than the flow rate diversion setpoint, followed by a delay of at least the minimum required holding time. The diversion device shall return to forward flow with sufficient delay between the two valve seats to ensure that all product contact surfaces between the two seats have been effectively heat treated, as described in section 19.3.6, “Timing of valve returning to forward flow position” of this code.

## 18 Holding Tube

### 18.1 Purpose

The holding tube provides the means of ensuring that the product, in continuous flow, is held at not less than the pasteurising temperature for not less than the specified holding time.

### 18.2 Design Requirements

**18.2.1** Dairy produce should be in fully developed turbulent flow (a Reynolds number greater than 4000) throughout the holding tube to ensure an even temperature distribution and to ensure that every particle is held for the minimum holding time.

Laminar flow (assumed if the Reynolds number is less than 4000) is allowable. In this case the holding time shall be calculated, and the maximum velocity shall be taken as twice the average velocity based on the maximum flow rate.

**18.2.2** Every particle of dairy produce shall be held for the minimum holding time required.

Note: this is a minimum holding time and not an average holding time. For the required minimum holding times see section 2, "Heat Treatment to Achieve Pasteurisation".

**18.2.3** The holding tube shall have a continuous upward slope of at least 1:50 in the direction of flow so as to avoid entrapment of air in the tube. The holding tube is defined as beginning at the point where upward slope commences and finishing at:

either

- the primary divert valve which is positioned at the high point of the holding tube

or

- the highest point prior to the heat exchanger, when the divert valves are positioned downstream from the heat exchanger.

**18.2.4** No section of the holding tube shall be heated or cooled.

**18.2.5** No provision shall be made for altering the holding tube in a way that would result in the holding time becoming less than the minimum.

**18.2.6** The holding tube shall be provided with the fittings required by section 18.3, "Fittings".

**18.2.7** The temperature difference across the radius of holding tubes shall not be greater than 0.5 °C. This can be assumed where the holding tube diameter is no larger than 150 mm and in larger diameter holding tubes where the Reynolds number is greater than 4000.

### **18.3 Fittings**

#### **18.3.1** For temperature measurement

The holding tube shall be provided with appropriate fittings to mount a cross check temperature indicator (refer to section 19.5, "Temperature Indicators") and for the pasteurising temperature sensor (refer to section 19.3, "Temperature Diversion Control").

The cross check temperature indicator and pasteurising temperature sensor shall be located as close together in the holding tube as is practicable so that a true comparison between the readings can be made.

The sensors shall be positioned as required in section 19.3.4, "Position of the temperature sensor".

The sensors and associated sensor pockets shall be readily removable from the piping system to allow testing to take place (refer to section 7.2.1).

#### **18.3.2** For testing holding time

Appropriate fittings shall be provided to enable the holding time within the holding tube to be measured by means of a conductivity test.

To achieve this, there shall be appropriate fittings at each end of the holding tube. It is recommended that there be 90 mm long spool pieces at each end of the holding tube. The spool pieces shall have one male and one female RJT union. Provision shall be made so that the fittings can be installed when the test is to be carried out.

**18.3.3 For flow rate determination**

18.3.3.1 Provision shall be made for installing a calibrated check flow meter. One method of achieving this is to provide a 900 mm long spool piece in the piping system outside the conductivity test spool pieces at a point where the flow is the same as in the holding tubes. The spool piece shall be horizontal or rise in the direction of flow and shall have male RJT threaded fittings on both ends of the spool piece. Alternative fittings are allowable where they have been agreed to by the recognised person assessing the pasteuriser.

18.3.3.2 To eliminate inaccuracies in flow measurement caused by flow swirl created by pipe bends, valves and other fittings there shall be designed into the pipework a minimum of ten pipe diameters of straight pipe upstream from the flow meter sensors and a minimum of five pipe diameters of straight pipe downstream from the flow meter sensors.

This applies to pipes of greater than 63.5 mm diameter. Pipes of 63.5 mm diameter and less have sufficient straight pipe lengths in the 900 mm spool piece (refer to Table below).

**Table: Pipe Diameters**

Pipe diameter	Minimum straight pipe length upstream from the 900 mm spool	Minimum straight pipe length downstream from the 900 mm spool
76.5 mm	300 mm	
100 mm	550 mm	50 mm
150 mm	1050 mm	300 mm
200 mm	1550 mm	550 mm

---

## 19 Diversion System

### 19.1 General

There shall be a diversion system consisting of a temperature sensor and a flow diversion controller that activates a flow diversion device. This system shall operate in a manner which ensures that no unpasteurised dairy material goes into the forward flow line.

### 19.2 Flow Diversion Device

#### 19.2.1 Function

The function of the flow diversion device is to divert any dairy material that fails to reach the specified pasteurising conditions back to the raw product balance tank, or divert dairy material from forward flow in such a manner that the storage and further processing of the diverted dairy material shall not adversely affect its quality. The flow diversion device provides two valve seats with leak escape between the two seats large enough to handle the maximum processing flow rate without significant pressure drop, to prevent contamination of pasteurised dairy material by unpasteurised dairy material.

#### 19.2.2 Activation

The diversion device shall switch to the divert position for all events that may compromise food safety. These events include but are not limited to the following:

- when the product temperature is equal to or below the divert temperature setpoint;
- when the flow rate is equal to or above the flow rate diversion setpoint (refer to section 17.7, “Protection Systems for High Flow Rates”);
- when no signal is received from the flow rate monitor (refer to section 17.7, “Protection Systems for High Flow Rates”);
- when there is failure of power supplied to the pasteurisation equipment;
- when the compressed air supply to the flow diversion device fails;
- when the temperature sensor fails with a full scale reading;

- 
- when the scan time is greater than the nominated maximum scan time (refer to section 20.2.2, “Response time of the differential pressure recorder and recycle system”);
  - when the recycle valve (if required) has been commanded to recycle but the recycle feedback signal has not been received within a system response time (refer to section 20.2.2, “Response time of the differential pressure recorder and recycle system”);
  - when the recycle valve (if required) has been commanded to forward flow but the recycle feedback signal is still received after a system response time.

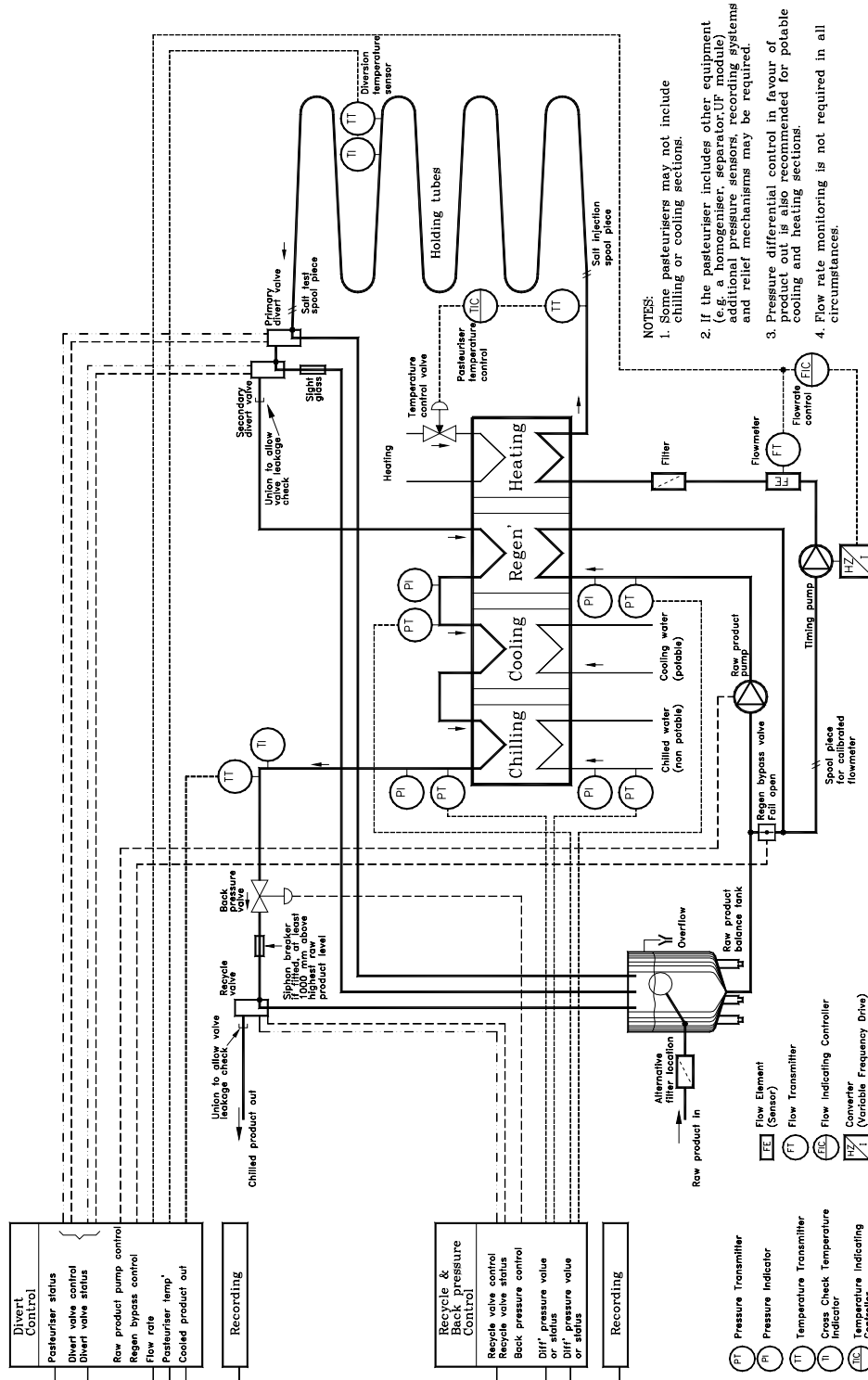
If the diversion valves are outside the pasteuriser and differential pressure failure protection is required, and a differential pressure recycle valve is not fitted, then diversion shall occur when:

- the differential pressure is equal to or less than the differential pressure recycle setpoint;
- any raw product pressure instrument is faulty and the signal drops to a lower than true pressure;
- any pasteurised milk instrument is faulty and the signal rises to a higher than true pressure.

When the diversion device is triggered, a means should also be provided to simultaneously stop the raw product feed pump to ensure that the differential pressure (refer to section 20.2.1, “Maintenance of differential pressure”) is maintained. The raw product side of the regenerator may also be bypassed, with product feeding directly to the timing pump.

Following activation of the diversion device by any of the events listed in this section, depending on the diversion device location, forward flow shall resume as described in section 19.2.8, “Location” or section 19.3.6, “Timing of valve returning to forward flow position” (refer to diagram below: “Pasteuriser Configuration”).

**Diagram: Pasteuriser Configuration:** a typical HTST pasteuriser layout drawn in diverted (failsafe) configuration



### 19.2.3 Two three-port valves

Two three-port valves (known as the primary and secondary divert valves) connected in series can satisfy the requirements of section 19.2.1, “Function” for a diversion device.

### 19.2.4 Primary divert valve

The primary (upstream) divert valve shall, when de-energised, divert dairy material back to the raw product balance tank or to waste.

### 19.2.5 Secondary divert valve

The secondary (downstream) divert valve shall, when de-energised, divert any leakage across the primary divert valve seat, back to the balance tank or to waste. The secondary divert valve thus prevents leakage across the primary divert valve from contaminating pasteurised dairy material in the forward flow line.

### 19.2.6 Separate lines

The primary and secondary divert valves shall divert product through separate lines known as the “divert line” and the “leak escape line”, respectively.

### 19.2.7 Timing of valve switching to divert position

When switching from the forward flow position to the divert position, the secondary divert valve shall operate simultaneously with the primary divert valve.

When either divert valve is commanded to divert and either divert feedback signal is not received within 10 seconds:

either

- the recycle valve shall recycle;

or

- the raw product feed pump and the timing pump shall stop.

For timing of the valve returning to the forward flow position (refer to section 19.3.6, “Timing of valve returning to forward flow position”).



### 19.2.8 Location

The primary divert valve shall be positioned:

either

- at the end (which is also the high point) of the holding tube;

or

- downstream from the regenerator, cooling and chilling sections.

If the flow diversion device is located downstream from the regenerator, cooling and chilling sections, and a recycle valve is not included, the primary divert valve shall be located according to section 20.3.2, "Location".

If the flow diversion device is located downstream from the regenerator, cooling and chilling sections, forward flow shall not resume until:

either

- all product contact surfaces between the holding tube and flow diversion device have been held at or above the required pasteurising temperature, continuously and simultaneously for at least the required pasteurisation time defined in section 11.2 of this document;

or

- the pasteuriser has been cleaned and sanitised.

The secondary divert valve shall be positioned downstream from and as close as practicable to the primary divert valve.

### 19.2.9 Divert and leak escape lines shall drain

The primary and secondary divert valves shall be installed so as not to retain any diverted dairy material when in the forward flow position. Divert and leak escape pipelines shall slope to allow free drainage to the balance tank (or to waste) and the leak escape line shall be free from valves or other devices that could restrict such free drainage. Where the leak escape line is piped directly to the balance tank, provision shall be made for seeing whether leakage is occurring during divert and lines shall terminate at least two pipe diameters above the overflow level. This will normally require the balance tank to have provision for overflow to limit the maximum product level. Where leakage past the primary divert valve seat cannot

otherwise be readily checked, a viewing port shall be installed in the leak escape line as close as practicable to the secondary divert valve.

Note: when divert valves are selected, the problem of water hammer should be considered.

#### **19.2.10 Double safety connection for divert valve feedback**

The preferred method of generating the valve position feedback signal is to take it from the position of the valve stem.

If the divert valve feedback signal is generated from the position of the actuator shaft rather than the valve stem, the valve stem shall have a double safety connection to the actuator shaft to maintain the integrity of the connection between the valve stem and the actuator shaft.

Note: a screwed connection that is also pinned through both the actuator shaft and the valve stem, a bolted connection that also has the nut pinned through the bolt, or use of a chemical locking agent applied in accordance with the manufacturer's instructions would satisfy this requirement.

Where butterfly valves are used, the feedback shall be taken from the valve shaft.

#### **19.2.11 Double-seated sanitary valve with leak escape**

Double-seated valves may be used to fulfil the combined function of the primary and secondary divert valves. When selected, the requirements of section 19.2.1, "Function" shall be satisfied.

Note: this will require that the two valve seats can be lifted independently of one another, and that the leak escape system can accommodate the full flow rate as required by section 19.3.6, "Timing of valve returning to forward flow position".

### **19.3 Temperature Diversion Control**

#### **19.3.1 Pasteurising temperature sensor**

The signal to the pasteuriser temperature recorder and the temperature diversion controller shall come from the same temperature sensor.

If an additional pasteurising temperature sensor is used in the holding tube, diversion shall occur if the reading from either sensor falls below the temperature divert setpoint, and

forward flow shall not resume (as per section 19.3.6, “Timing of valve returning to forward flow position”) until readings from both pasteurising temperature sensors are above the temperature divert setpoint. In this case, the reading from the sensor closest to the divert valves shall be used for pasteuriser temperature recording.

### 19.3.2 Temperature readout accessibility

The temperature(s) used in the divert control logic shall be displayed and readily accessible to the operator. The pasteurising recording function (which shall be from the pasteurising temperature sensor located closest to the divert valves) may be on a separate instrument to the diversion function. Where this occurs, the two readings shall be displayed so that agreement between the instruments can be checked.

### 19.3.3 Accuracy

The temperature used for divert control, and the recording of this temperature, shall be accurate to within  $\pm 0.5$  °C in the range 3 °C above and below the diversion temperature.

### 19.3.4 Position of the temperature sensor

19.3.4.1 Position of the temperature sensor in relation to the flow diversion device will depend on the location of the diversion device:

At the end of the holding tube;

Where the flow diversion device is located at the end of the holding tube, the temperature sensor shall be situated at a sufficient distance upstream from the flow diversion device to ensure that when the sensor registers a product temperature below that specified, the low temperature product does not reach the diversion device before the device has moved fully to the diverted position, i.e. the temperature sensor shall be positioned no closer than one response time maximum flow equivalent upstream from the flow diversion device (refer to section 19.3.5, “Response time of the pasteurising temperature recorder and flow diversion system”). To minimise measurement errors due to temperature loss, the temperature sensor shall be no more than 5 seconds flow equivalent (calculated at the maximum flow rate) upstream from the flow diversion device;

At the end of the heat exchanger;

Where the flow diversion device is located at the end of the heat exchanger, the temperature sensor shall be located no more than 5 seconds flow equivalent upstream from the end of the holding tube.

19.3.4.2 For the location of an additional temperature sensor in relation to the flow diversion device for large size divert valves, it may not be possible to achieve a 5 second response time for the total diversion system due to the slow response time of the divert valve.

In this case, a second pasteurising temperature sensor that will also activate the diversion system shall be installed in the holding tube at a sufficient distance upstream from the divert valve to ensure that when the sensor registers a product temperature below that specified, the low temperature product does not reach the divert valve before the valve has moved to the fully diverted position.

Note: the requirement for the additional temperature sensor to be within 5 seconds flow equivalent of the diversion device is not applicable in this case (refer to section 19.3.1, "Pasteurising temperature sensor" for other requirements for the additional sensor).

#### **19.3.5** Response time of the pasteurising temperature recorder and flow diversion system

The system response time for flow diversion is the time constant of the temperature sensor added to the time then taken by the controller to act on that change and move the flow diversion device to the fully diverted position.

The system response time for the temperature recording function is the time constant of the temperature sensor added to the time taken by the recorder to register that information in the recording system.

The system response time for the flow diversion system shall be less than or equal to 5 seconds (i.e. the sum of one time constant for the temperature sensor, divert valve activation time and all other inherent delays in the control system shall be less than or equal to 5 seconds). Similarly the temperature recording system response time shall be less than or equal to 5 seconds.

One time constant for a temperature sensor can be measured by immersing the cold temperature sensor into a well-stirred water bath at 76 °C. The time interval between when the thermometer reads 65 °C and when it reaches 72 °C is one time constant for the instrument.

### 19.3.6 Timing of valve returning to forward flow position

When the pasteurising temperature sensor registers that the product is no longer cooler than the divert temperature set point, the diversion device shall return to the forward-flow position, but with sufficient delay to ensure the diversion of all product which at that time was between the temperature sensor and the diversion device. The delay required may be greater than the system response time (measured going to forward flow), in which case either a timer delay or a raised temperature set point for the return to forward flow shall be provided.

When the primary divert valve returns to forward flow, there shall be sufficient delay to ensure that all product contact surfaces between the primary divert valve and the secondary divert valve have been held at or above the required pasteurising temperature, continuously and simultaneously for at least the required pasteurising time defined in section 11.2 of this document, before the secondary divert valve returns to forward flow.

When either divert valve is commanded to forward flow and either divert feedback signal is still received after 10 seconds:

either

- the recycle valve shall recycle;

or

- the raw product feed pump and the timing pump shall stop.

## 19.4 Monitoring and Recording System

### 19.4.1 General

A means shall be provided to monitor and record the temperature to which the dairy material is heated, the temperature to which it is cooled (outgoing product temperature) where it is critical to product safety, and the status of the diversion devices. Monitoring systems shall include visual displays to allow pasteuriser operators to monitor the operation.

The pasteurisation temperature shall be recorded for the period from start-up until shut-down, including cleaning and sanitising cycles.

#### **19.4.2** Location of temperature sensors

The sensor(s) used to monitor the pasteurisation temperature is specified in section 19.3.4, “Position of the temperature sensor”. If more than one sensor is used, at least one pasteurising temperature sensor shall be located as defined in section 19.3.4.1.

The sensor to monitor the temperature of the product after cooling shall be located in the product flow near the cooled product outlet.

#### **19.4.3** Recording device

Refer to section 21, “Data Recording System” for requirements.

#### **19.4.4** Diversion devices recording

The status of both the primary and secondary divert valves shall be logged on a recording device. The signal, which shall be generated by each valve, will record when each of the valves is in the fully diverted position, and when each is not.

This can be achieved by recording each valve position separately or by using a single recording pen. Where a single pen is used, it shall have sufficient sensitivity so that the status of each valve can be identified. In the case of double seated valves, the status of both seats shall be recorded.

### **19.5** Temperature Indicators

**19.5.1** In addition to the pasteurising temperature sensor specified in section 19.3, “Temperature Diversion Control”, a cross check temperature indicator (refer to section 5.3.1.3, “Cross check temperature indicators”) shall be installed to enable the following temperatures to be read during plant operation:

- the product temperature as close as practicable to the pasteurising temperature sensor;
- the cold product temperature as it leaves the heat exchanger (where the temperature is critical to product safety).

If more than one pasteurising sensor is used, each sensor shall have an associated cross check temperature indicator.

**19.5.2** The operator shall be able to view the cross check temperature indicator and the pasteuriser divert temperature simultaneously.

## **19.6 Testing and Calibration**

The temperature diversion system equipment shall be able to be tested and calibrated (refer to section 7, “Testing and Calibration”).

---

## 20 Differential Pressure Control System

### 20.1 General

**20.1.1** The purpose of the automatic differential pressure control system is to maintain the pressure of the pasteurised dairy material above that of the unpasteurised dairy material and non-potable water to minimise the risk of contamination in the event of a heat exchanger failure.

**20.1.2** In the event of loss of differential pressure, product shall recycle when the differential pressure is equal to or less than the differential pressure recycle setpoint. Forward flow shall not restart until the pasteuriser has been sanitised by heating or cleaning.

**20.1.3** Differential pressures need not be measured or monitored in systems that have been designed in a manner that guarantees that the pressure of pasteurised product will remain at least 10 kPa above that of raw product and non-potable water supplies at all times. Where this option has been selected, a recycle valve is not required.

**20.1.4** Differential pressures are not required and do not need to be monitored in systems that have been engineered to guarantee pasteurised product cannot become contaminated with raw product or non-potable water supplies at all times, including equipment failure and fatigue. Where this option has been selected, a recycle valve is not required. This result can be achieved, for example, by using air gap plates which have leak escape passages between the plates, separating pasteurised product from raw product and non-potable water in the heat exchanger.

Where this option is employed, leak escape channels shall open to the atmosphere and shall be able to be readily and routinely checked for signs of leakage. Where leakage is detected, the affected plates shall be replaced as soon as practicable.

### 20.2 Differential Pressure Control

#### 20.2.1 Maintenance of differential pressures

Differential pressure control is achieved by maintaining the following differential pressures:



- The pressure of the pasteurised product on the pasteurised product side of regeneration sections and non-potable sections shall be greater than or equal to 10 kPa above the pressure of unpasteurised product or non-potable water on the unpasteurised side or non-potable water side of any common heat exchange surface.
- The pressure of the pasteurised product on the pasteurised product side of any heating or potable cooling section should also be greater than or equal to 10 kPa above the pressure of the heating or potable cooling medium on the heating or potable cooling medium side of any common heat exchange surface.

Differential pressures shall be maintained during both forward flow and diversion modes (or the differential pressure recycle system shall be activated). Activation of the differential pressure recycle system during diversion mode should be avoided to minimise downtime, product losses, and quality problems which may be associated with the activation of this system.

The differential pressures specified above may be maintained by means of a back-pressure inducing device installed in the outgoing product line.

#### **20.2.2** Response time of the differential pressure recorder and recycle system

The system response time for differential pressure recycle is the time taken by the differential pressure sensing system to register a given pressure change added to the time taken by the controller to act on that change and move the recycle valve to the fully recycled position.

The system response time for the pressure recording function is the time taken for the individual pressure sensors to register a given pressure change added to the time taken by the recorder to register that information in the recording system.

The system response time for the differential pressure recycle system shall be less than or equal to 5 seconds (i.e. the sum of one time constant for the pressure sensor, the recycle valve activation time, and all other inherent delays in the control system shall be less than or equal to 5 seconds). Similarly, the differential pressure recording system response time shall be less than or equal to 5 seconds.

One time constant for a pressure sensor can be measured by raising the pressure to 27.5 kPa, then rapidly dropping the pressure to 0 kPa. The time interval between the instrument reading 27.5 kPa and 10.0 kPa is one time constant for the instrument. (Note: this test shall be performed on the pressure sensors on both the high and the low sides of the differential pressure sensing system.)

### **20.2.3 Differential pressure failure**

If the differential pressure across any regeneration sections and/or chilling sections cannot be maintained as specified in section 20.2.1, “Maintenance of differential pressures”, the control device shall redirect product through the pasteuriser recycle valve (typically to the raw product balance tank or to waste).

### **20.2.4 Resumption of forward flow after differential pressure failure**

Forward flow may be resumed only after all parts of the pasteurised product sections of the heat exchanger up to the recycle valve have been continuously and simultaneously held at or above the pasteurisation temperature for the required time (as defined in section 11.2 of this document), or the pasteuriser has been cleaned and sanitised.

## **20.3 Differential Pressure Recycle Device**

### **20.3.1 Recycle valve**

The recycle valve shall, when de-energised, recycle product back to the raw product balance tank or to waste.

### **20.3.2 Location**

The recycle valve shall be positioned downstream from the outlet from the final section of the pasteuriser but at a distance sufficiently far downstream that the valve can be fully in the recycle position before any potentially contaminated product reaches the valve. The minimum distance downstream is calculated from the differential pressure system response time which is specified in section 20.2.2, “Response time of the differential pressure recorder and recycle system” of this document.

### **20.3.3 Recycle line**

The recycle valve shall be installed so as not to retain any recycled product when in the forward flow position. The recycle pipeline shall slope to allow free drainage to the balance tank (or to waste) and the recycle line shall be free from valves or other devices that could restrict such free flow. Where the recycle line is piped directly to the balance tank, the line shall:

either

- terminate at least two pipe diameters above overflow level (this will normally require the balance tank to have a provision for overflow to limit the maximum product level);

or

- for products that are froth sensitive, the recycle line may finish below the liquid level if it is fitted with a siphon breaker.

The recycle valve shall be piped in a manner that allows the forward flow line to be disconnected to allow the valve to be readily checked for leakage to forward flow when the valve is in the recycle position.

#### **20.3.4 Activation**

The recycle valve shall switch to the recycle position for all events that may compromise food safety.

These events include but are not limited to the following:

- when the differential pressure is equal to or less than the differential pressure recycle setpoint;
- when any raw product pressure instrument is faulty and the signal drops to a lower than true pressure;
- when any pasteurised product pressure instrument is faulty and the signal rises to a higher than true pressure;
- when there is failure of power supplied to the pasteurisation equipment;
- when the compressed air supply to the recycle valve fails;
- when the scan time is greater than the nominated maximum scan time;
- when the flow rate is equal to or above the flow rate diversion setpoint (refer to section 17.7, "Protection Systems for High Flow Rates");
- when no signal is received from the flow rate monitor (refer to section 17.7, "Protection Systems for High Flow Rates");
- when either divert valve is commanded to divert and either divert feedback signal is not received within 10 seconds (refer to section 19.2.7, "Timing of valve switching to divert position").

Following activation of the recycle valve by any of the events listed in this section, forward flow shall resume as described in section 20.2.4, “Resumption of forward flow after differential pressure failure”.

To assist in identifying divert valve feedback faults, it is advisable to switch the recycle valve to the recycle position when either divert valve is commanded to forward flow and either divert feedback signal is still received after 10 seconds (refer to section 19.3.6, “Timing of valve returning to forward flow position”).

#### **20.3.5 Double safety connection for recycle valve feedback**

The preferred method of generating the valve position feedback signal is to take it from the position of the valve stem.

If the recycle valve feedback signal is generated from the position of the actuator shaft rather than the valve stem, the valve stem shall have a double safety connection to the actuator shaft to maintain the integrity of the connection between the valve stem and the actuator shaft.

Note: a screwed connection that is also pinned through both the actuator shaft and the valve stem, a bolted connection that also has the nut pinned through the bolt, or use of a chemical locking agent applied in accordance with the manufacturer’s instructions would satisfy this requirement.

Where butterfly valves are used, the feedback shall be taken from the valve shaft.

#### **20.4 Differential Pressure Data Recording**

The differential pressure control system shall continuously (refer to section 5.4.1.7, “Requirements for “continuous” recording”) record:

- the value or status of the differential pressures;
- the position of the pasteuriser recycle valve; either fully in recycle position or not in recycle position.

A single pen may be used to record more than one switch status if the status of each switch can be clearly identified.

## 20.5 Prevention of Siphoning

A siphon breaker should be used to assist in maintenance of differential pressures when the pasteuriser is on divert or is temporarily stopped. If differential pressures can be maintained during a divert, considerable savings are possible by not having to re-sanitise the pasteurised side of the heat exchanger prior to returning to forward flow, as required in section 20.2.4, "Resumption of forward flow after differential pressure failure".

The siphon breaker should be located at a position at least 1 m (i.e. 10 kPa) higher than the highest raw product point in the pasteuriser.

The recycle valve may be used as a siphon breaker.

If used, the siphon breaker shall be able to be:

- cleaned in place;
- readily dismantled to enable the ability to be cleaned to be assessed.

## 20.6 Testing and Calibration

Differential pressure monitoring/control equipment shall be able to be tested and calibrated (refer to section 7, "Testing and Calibration" for requirements).

---

## 21 Data Recording System

### 21.1 Purpose

A data recording system with a circular or strip chart, or an electronic data recording system, shall be installed to provide a “continuous” (see section 5.4.1.7, “Requirements for “continuous” recording”) and permanent record of all essential information and shall comply with section 5 “Data Collection and Recording System” of this Code.

### 21.2 Data to be Recorded

The following data shall be permanently recorded during plant operation and cleaning:

- the date and time of day (where time recording is automated, records shall be kept of daylight saving changes);
- the flow rate (refer to section 17.4);
- the pasteurisation temperature, accurate to  $\pm 0.5$  °C for the period from start-up until shut-down and including the temperature and duration of the cleaning and sanitising cycles (refer to section 19.4.1, “General”);
- the status of the temperature diversion devices (see section 19.4.1, “General”);
- the temperature of the outgoing product where the temperature is critical to product safety (refer to section 19.4.1, “General”);
- the pasteuriser status (distinguishing at least between cleaning and production) where cleaning systems have divert valve over-rides, or where there are data recording requirements for cross connections between pasteurised dairy material and unpasteurised dairy material (refer to section 3.2.4);
- the status of any cross connections between pasteurised dairy material and unpasteurised dairy material lines at all times, including pasteuriser production, cleaning, shutdown, etc. (refer to section 3.2.4);
- the divert flow rate setpoint (only required for systems that test the activation of the high flow rate protection system by lowering the divert flow rate setpoint until activation occurs) (refer to section 7.4.1.4, “Flow”).

---

## 22 General Requirements for Vacuum Steam Pasteurisers

### 22.1 Scope & Background

This section describes the requirements for vacuum steam pasteurisers, a heat treatment method that is considered to be neither batch pasteurisation nor HTST pasteurisation. Vacuum steam pasteurisation means continuous pasteurisation utilising a procedure that combines a pasteurisation heat treatment with the process of removing taint-causing volatiles to acceptable levels by steam stripping while under vacuum. Although vacuum steam pasteurisation is most commonly used in New Zealand for removing feed-related taints from cream and cream products, it can also be used to treat other dairy materials where taint removal is important.

### 22.2 Vacuum Steam Pasteurisation

The aim of pasteurisation is to avoid public health hazards arising from pathogenic micro-organisms associated with raw milk and milk derivatives and to reduce spoilage organisms using a heat treatment process which causes minimal chemical, physical and sensory changes in the dairy materials.

Taint removal from cream is an important step when manufacturing cream products, particularly when the source milk is derived from pasture-fed animals. In New Zealand, taint-causing volatiles are reduced to acceptable levels by steam stripping while under vacuum. To reduce damage to the fat component of the cream by excessive handling or heat treatment, the processes of taint removal and pasteurisation are often combined into the one process.

The design and appearance of a vacuum steam pasteuriser differs from that normally associated with and recognised as a HTST pasteuriser. This section describes the minimum requirements to be followed when designing a vacuum steam pasteuriser to provide assurance that the dairy material has been fully pasteurised.

### **22.3 Heat Treatment delivered by Vacuum Steam Pasteurisation**

The heat treatment delivered by a vacuum steam pasteurisation system shall comply with section 11.2, of this code. Where the designated heat treatment step is a vacuum steam pasteuriser, the equipment used shall comply with this code.

Different time/temperature pasteurisation combinations may be used for different product specifications, provided they meet the requirements of section 11.2.



## 23 General Design Parameters

### 23.1 Components of a Vacuum Steam Pasteurisation System

Vacuum steam pasteurisation systems shall include the following items of equipment:

- a raw product balance tank;
- a heat exchanger;
- a filter or centrifuge (where not incorporated elsewhere upstream from the vacuum steam pasteurisation system);
- a flow rate control system;
- a vapour-liquid separation section;
- a holding section;
- a product outlet pump;
- a temperature diversion system;
- either a differential pressure system or a failsafe system as described in sections 20.1.3 and 20.1.4;
- a data recording system.

Vacuum steam pasteurisation systems may also include:

- a raw product pump;
- an intermediate balance tank.

### 23.2 Design and Fabrication

The design and fabrication of the vacuum steam pasteurisation system shall comply with section 3, "Design and Fabrication of Pasteurisation Equipment" of this code.

### **23.3 Raw Product Balance Tank**

A raw product balance tank is required to assist in maintaining constant flow conditions through the pasteuriser, and may provide a return point for product diverted by the divert and recycle valves, and may assist with the maintenance of differential pressures. The raw product balance tank shall comply with section 12, “Raw Product Balance Tank” of this code.

If the vacuum steam pasteurisation system is provided with a raw product pump, it shall comply with section 13, “Raw Product Pump” of this code.

### **23.4 Intermediate Product Balance Tank**

If the vacuum steam pasteurisation system is provided with an intermediate product balance tank, it shall comply with section 15, “Intermediate Balance Tank” of this code.

### **23.5 Flow Rate Control System**

**23.5.1** Vacuum steam pasteurisation systems shall have a flow rate control system to ensure that the product flow through the holding section does not exceed the design flow rate.

**23.5.2** The flow rate control system shall comply with section 17, “Timing Pumps and Other Flow Rate Control Systems” of this code, except that the flow rate measuring device shall be located immediately downstream from the holding tube and upstream from the divert valves.

### **23.6 Heat Exchanger**

#### **23.6.1 Purpose**

The purpose of the heat exchanger is to preheat the raw product before it enters the vacuum steam pasteuriser, and to cool the pasteurised product to a specified temperature consistent with section 11.2 of this code.

#### **23.6.2 Design**

The heat exchanger shall comply with section 14, “Heat Exchanger” of this Code.

### **23.7 Filter or Centrifuge**

When the dairy material has not been previously filtered or centrifuged to remove particulate matter, or where the product has been handled in a manner that would allow it to become re-contaminated with particulate matter (e.g. after road transport, reprocessing, addition of re-melt or additives), the pasteuriser shall have a filter or centrifuge located before the final heating section. Particulate matter can protect micro-organisms from receiving the specified heat treatment.

Filters shall have a maximum pore size of 200 µm, 500 µm, or 1000 µm in order to meet the respective maximum particle size limits described in section 2 and the table in 2.4.4 of this code. Where a centrifuge is used the time temperature requirements specified for a 200 µm filter shall apply.

### **23.8 Vapour-Liquid Separation Vessel and Condenser**

#### **23.8.1 General**

Vacuum is created with the aid of a vacuum pump or ejector and by condensing the vapours and steam.

Vapours and steam are condensed using cold water. This can be achieved:

either

- directly by direct contact with cold water sprayed into the condenser;

or

- indirectly by passing cold water through condenser pipes or plates.

Direct condensers shall use only potable water. Indirect condensers may use potable or non-potable water.

#### **23.8.2 Design**

The vapour-liquid separation vessel and condenser shall be accessible for inspection and cleaning.

Any direct steam injection in these vessels shall comply with the requirements in section 14, "Heat Exchanger" of this code.

## 23.9 Holding Section

### 23.9.1 General

The holding section provides the means of ensuring that the dairy material, in continuous flow, is held at not less than the pasteurising temperature for not less than the specified time (as defined in section 11.2 of this code).

There shall be a designated holding section for which the minimum holding time and temperature is nominated. The holding section may be in the form of a holding tube or may be a designated portion of the steam stripping and vapour-liquid separation sections of the vacuum steam pasteuriser in which the minimum residence time can be measured and the minimum temperature can be measured (e.g. the Flavourtech spinning cone column or one or more vapour-liquid separation vessels of the Vacreator). The preferred option is a holding tube.

The minimum holding time and temperature shall be able to be measured.

### 23.9.2 Holding tubes

Where used, holding tubes shall comply with section 18, "Holding Tube" of this code.

There are three options for the location of the holding tube on a Vacreator:

- after the pre-heater, before the product enters the first separating body where the product temperature is about 82 °C;
- after the second separating body, i.e. on discharge side of the intermediate pump, where the product is about 89 °C;
- after the fourth separating body where the product is about 94 °C, prior to where the product enters the flash cooling vessel.

The required holding times for dairy material at these temperatures can be obtained from section 11.2.

The simplest and cheapest location for the holding tubes is normally the first option. The raw product balance tank and Vacreator feed pump (raw product pump) act as the raw product tank and timing pump respectively and a holding tube (determined from section 11.2) is required downstream from the pre-heater or plate heat exchanger.

The main problem with the second and third options is that product is being drawn from a vessel under vacuum. Thus for the second option the vacuum vessels become the raw

product balance tank or intermediate product balance tank and the intermediate pump becomes the timing pump. For the third option there is no timing pump, as the product is driven by pressure alone, so there is no way of ensuring constant flow.

The second and third options require more extensive modification to meet the requirements of this code. There is also the chance of air leaks, which can alter the flow rate through the holding tube and thus alter the holding time.

### **23.9.3** Designated portion as the holding section

Where the holding section includes the steam stripping section and/or the vapour-liquid separation vessels, the temperature may vary over the length of the holding section, and the residence time may be dependent on the equipment operating conditions. In this case:

- Every particle of product shall be held for the minimum holding time required. Note: this is a minimum holding time and not an average holding time. For the required minimum holding times refer to section 11.2.
- Fittings shall be provided to allow the minimum residence time to be measured using the salt conductivity test (refer to section 18.3.2, “For testing holding time”). No provision shall be made for altering the holding section in such a way that the holding time becomes less than the minimum.
- The minimum holding temperature shall be able to be measured. Temperature sensors used for controlling flow diversion shall be positioned so that minimum temperature is measured. Because the product temperature may vary over the length of the holding section, the temperature shall be measured at the entry and exit of the holding section.
- Unless the equipment has been designed to guarantee that the entry temperature to the holding section will always be higher than the exit temperature, the temperature sensor at the entry of the holding section shall also be able to activate diversion on low temperature and the temperatures at both the entry and exit of the holding section shall be recorded.
- Each temperature sensor supplying a signal to the temperature divert controller shall have an associated adjacent temperature sensor that supplies a signal to a cross check temperature indicator.
- The vacuum steam pasteuriser shall have provision for installing a calibrated check flow meter in a position that allows the product flow rate through the holding section to be measured.

- Fittings shall comply with section 18.3, “Fittings”.

### **23.10 Product Outlet Pump**

The function of the product outlet pump, in conjunction with the back pressure inducing device, is to ensure that the differential pressures specified in section 20, “Differential Pressure Control System” are maintained.

---

## 24 Control Systems

### 24.1 Temperature Diversion System

Vacuum steam pasteurisers shall have a temperature diversion system to ensure that no unpasteurised dairy material goes into the forward flow line. If flow diversion occurs upstream from a direct steam injection unit or other heating section, a potable water flush may be required to prevent burn-on.

The temperature diversion system shall comply with section 19, "Diversion System" of this code.

### 24.2 Differential Pressure Control System

Vacuum steam pasteurisers shall:

either

- have a differential pressure control system to maintain the pressure of pasteurised dairy material above that of the unpasteurised dairy material and non-potable water to minimise the risk of contamination in the event of a heat exchanger failure;

or

- shall be designed as described in sections 20.1.3 or 20.1.4.

The differential pressure control system shall comply with section 20, "Differential Pressure Control System" of this code.

### 24.3 Data Recording System

The data recording system shall comply with sections 5, "Data Collection and Recording Systems" and 21, "Data Recording System" of this code.

### 24.4 Computer Control Systems

Computer control systems shall comply with section 4, "Computer Control Systems" of this code.

#### **24.5 Testing and Calibration**

Instrumentation control systems, computer programmes and safety features shall be accessible and able to be tested, calibrated and examined. Testing and calibration programmes shall comply with section 7, “Testing and Calibration” of this code.

#### **24.6 Critical Parameter Security**

Critical control set points shall be controlled to prevent unauthorised alterations. Control systems and procedures for making alterations shall comply with section 6, “Critical Parameter Security” of this code.



---

## 25 General Requirements for Evaporators and Concentrate Pasteurisers

### 25.1 Scope and Background

This section describes the requirements for pasteurisers incorporated with evaporators. This is a heat treatment method that is essentially HTST pasteurisation. The heat treatment step is:

either

prior to the first effect of the evaporator in the flash vessels preheaters;

or

after the evaporator pre heaters, but prior to the first effect;

or

in the concentrate heaters prior to the drier.

Heat treatment cannot be certified within the evaporator itself due to the unknown nature of the falling film of product in the calandrias and the cross contamination caused by the vapour paths.

Lower heat product specifications have been emerging with new processes, such as milk protein concentrate powders. It may be unsuitable to pasteurise these products in this part of the process due to the effect on product functionality.

The design and appearance of an evaporator or concentrate pasteuriser differs from that normally recognised as a pasteuriser. This section describes the minimum requirements for an evaporator or concentrate pasteuriser to provide assurance that the product has been fully pasteurised.

### 25.2 Heat Treatment to Achieve Pasteurisation

The heat treatment delivered by an evaporator or concentrate heater pasteurisation system shall comply with section 11.2 of this code. Where the designated heat treatment step is an evaporator or concentrate heater pasteuriser, the equipment used shall comply with this code.

Different time/temperature pasteurisation combinations may be used for different product specifications, provided they meet the requirements of section 11.2.

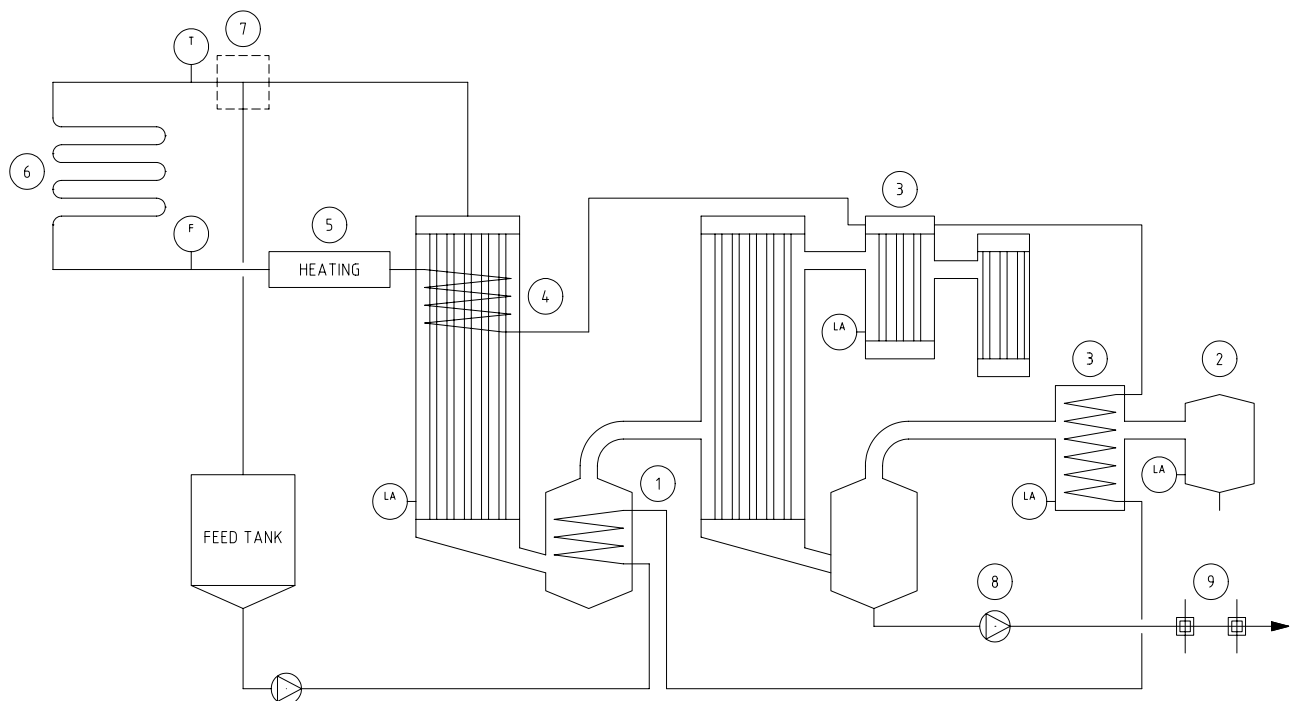
## 26 General Design Parameters

### 26.1 Components of an Evaporator Preheat Pasteurisation System

#### 26.1.1 General

The pasteurisation (holding time and temperature measurement) is done prior to the dairy material entering the first effect of the evaporator, refer to diagram below: Evaporator Preheat Pasteurisation Options.

**Diagram: Evaporator Preheat Pasteurisation Options**

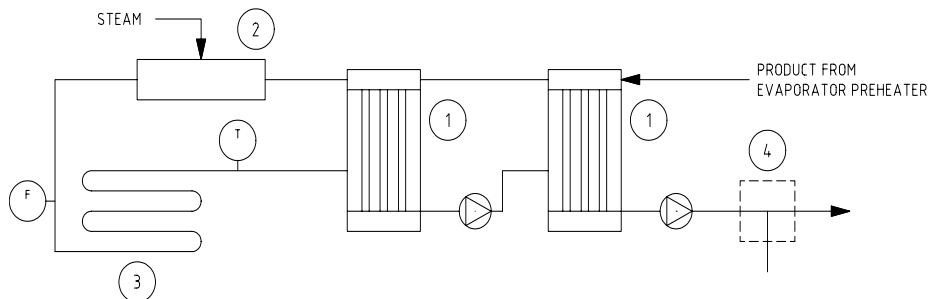


**NOTES**

1. PREHEATER IN SEPARATOR VESSEL (DISALLOWED)
2. CONDENSOR
3. PREHEATER SEPARATE FROM CALANDRIA
4. PREHEATER IN VAPOUR SIDE OF CALANDRIA
5. DIRECT OR INDIRECT HEATING
6. PASTEURISATION SECTION
7. OPTIONAL DIVERT STATION
- 8 & 9. OPTIONAL CONTROLLED CONCENTRATE PUMP & RECOVERY SYSTEM.

Where indirect preheater flash vessels are used, pasteurisation holding can be immediately prior to the cooling section of the preheaters, refer to diagram below; or immediately after as for direct contact preheaters, refer to diagram Pasteuriser holding immediately after the cooling section of the preheaters.

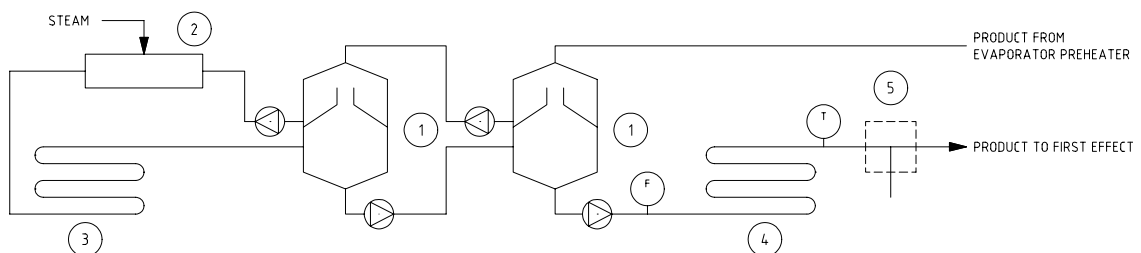
**Diagram: Pasteuriser holding prior to the cooling section of the preheaters**



- NOTES**
1. INDIRECT CONTACT PREHEATER
  2. DIRECT STEAM INJECTION HEATING
  3. PASTEURISATION SECTION
  4. OPTIONAL DIVERT STATION

Where direct contact preheater flash vessels are used, the pasteurisation holding and temperature measurement are after the product has left the heating and cooling stages of the preheaters, refer to Diagram below.

**Diagram: Pasteuriser holding immediately after the cooling section of the preheaters**



- NOTES**
1. DIRECT CONTACT PREHEATER FLASH VESSEL
  2. DIRECT STEAM INJECTION HEATING
  3. HOLDING TUBES
  4. PASTEURISATION SECTION
  5. OPTIONAL DIVERT STATION

These options are only possible if the evaporator preheat sections (within the evaporator) can be shown to have no potential for cross contamination. In evaporators where the preheaters are immediately over or in the pasteurised product space then this is not possible. Location of the preheater above the separation vessels does not allow for physical control of contamination in the event of a leak, due to the geometry of the equipment.

Process temperature and time combinations are often in excess of the requirements for pasteurisation. This alone is insufficient, due to the possibilities of cross contamination in the flash cooling and regenerative heating sections. These sections are usually open to each other and rely on vapour flow in one direction.

### 26.1.2 Equipment

The pasteurisation systems shall typically include the following items of equipment:

- a product balance tank (to avoid siphoning);
- a filter or centrifuge (where not incorporated elsewhere upstream from the evaporator pasteurisation system);
- a heating system;
- a timing pump, flow rate control or limiting system;
- a holding section;
- a diversion or flow stopping system (diversion prior to first effect or prior to the concentrate tank);
- a data recording system.

## 26.2 Components of a Concentrate Pasteurisation System

### 26.2.1 General

The pasteurisation holding and measurement is done prior to the dairy material entering the drier, refer to diagram in section 26 Flow Diversion for Concentrate Systems.

#### *Commentary*

*This is only possible if the drier is set up with an emergency water system that allows for product feed to be lost, while still controlling chamber temperature.*

### 26.2.2 Equipment

The pasteurisation systems shall include the following items of equipment:

- a product balance tank, and agitator; (to avoid siphoning and provide a homogeneous feed);
- a timing pump flow rate control or limiting system;
- a filter or centrifuge (where not incorporated elsewhere upstream from the concentrate pasteurisation system);

- a heating system;
- a holding section;
- a diversion system or flow stopping system (prior to the drier);
- a data recording system.

### **26.3 Design and Fabrication**

The design and fabrication of the pasteurisation system shall comply with section 3, “Design and Fabrication of Pasteurisation Equipment” of this code.

### **26.4 Product Balance Tank**

A product balance tank is required to:

- assist in maintaining constant flow conditions through the pasteuriser;
- provide a return point for product diverted by the divert and recycle valves if required;
- separate this pasteuriser from the previous process;
- prevent siphoning.

The raw product balance tank shall comply with section 12, “Raw Product Balance Tank” of this code, i.e. concentrate tank or evaporator balance tank.

The requirements for constant level in section 12 may not be achievable in this application. The flow control system shall maintain a constant flow, while accommodating these variations.

The average residence holding time requirements of section 12 are not applicable to concentrate product balance tanks.

The requirements of section 12 do not apply to CIP nozzles that are fitted to a balance tank to clean agitators.

### **26.5 Product Pump**

If the pasteurisation system is provided with a raw product pump, it shall comply with section 13, “Raw Product Pump” of this code, except for the requirement that the feed to the evaporator should not be interrupted.

## 26.6 Flow Rate Control Systems (Evaporators and Concentrate Heaters)

The pasteurisation systems shall have a flow rate control system to ensure that the product flow rate through the holding section is not less than the required holding time.

**26.6.1** In the case where the holding tube is fed from a preheater vessel which is under vacuum, it is recognised that pump suction level control is critical to retain the hydraulic seal of the vessel, and avoid two phase flow.

In this case it is recognised that the flow will fluctuate with the vacuum level and liquid level in the preheater. If the level is not controlled within a normal operational range, operation of the corrective action system is required to ensure that air or vapour can not be incorporated.

**26.6.2** The flow rate control system shall comply with section 17, “Timing Pumps and Other Flow Rate Control Systems” of this code.

**26.6.3** As an alternative to using a timing pump, a holding section that is long enough to allow for the maximum flow rate possible is acceptable. In this case a flow rate control system is not required.

### Commentary

*In the case of an evaporator, the flow controller is fitted after the product feed balance tank, meaning there may be no flow rate control system in the holding tube. In this case flow is to be separately monitored in the holding section. To accommodate for flow fluctuations, the requirements of section 17.1.2 for a flow rate of  $\pm 5\%$  may be increased, provided the holding time is similarly lengthened to accommodate this.*

*Another option is to lengthen the holding section to correspond with the maximum flow rate of the feed pump (including fluctuations). In this case flow monitoring of the holding section is not required, nor are flow diversion systems for high flow rates.*

## 26.7 Preheaters Internal in the Evaporator

The layout of the product preheaters in the evaporator, which are being used to condense vapours of pasteurised products shall prevent any overflow of condensate from flooding back into a product area. This can be achieved by:

either

- physical layout not allowing a direct path;

or

- a condensate flooding level alarm, which shall alarm at high level.

#### *Commentary*

*Cross contamination is possible if a leak develops in the preheaters. The preheaters will be at a pressure as supplied by the feed pump, the evaporator will be at a vacuum dependent on the respective effect that preheater is in. The pressure differential would cause flow of unpasteurised dairy material into the pasteurised dairy material. (see first diagram in section 26)*

This is to be controlled by physically locating the preheaters:

either

- in a separate vessel on the vapour side of the evaporator (see third diagram in section 26);

or

- in the vapour side of the Callandria old designs (see diagram in section 26.11).

In each of the above cases the condensing vapour level should be low. If there is a significant level it could indicate the leakage of raw product into the vapour space. This will show up in the condensate draining from this vessel. This condensate is to be inspected at least once during normal operation.

### **26.8 External Flash Vessel Preheaters Prior to the First Effect of the Evaporator**

Where a flash vessel is used after the pasteurisation step, the product on the other stream of the vessel is to be from a pasteurised or potable source.

#### *Commentary*

*With open (direct contact) flash vessel preheaters, cross contamination is likely to occur in normal operation between incoming product and product leaving the preheaters. For this reason the product in this area is considered raw product and the pasteurisation section shall be after such a vessel, see third diagram in section 26.*



---

*With indirect contact flash vessel preheaters, e.g. shell and tube heat exchangers, this is not the case and the preheater holding tube could be used as the pasteurisation step, see second diagram in section 26.*

## **26.9 Cross Connections**

Any section of an evaporator or heat treatment system containing non-pasteurised dairy material shall be separated from any section containing pasteurised dairy material. Separation shall comply with section 3.2, "Acceptable Cross Connections" of this Code, requiring an atmospheric break.

Non-condensable gas lines on evaporators may run to common vacuum pumps provided they are monitored, to ensure one is always operational. The failure of the duty vacuum pump shall activate a flow divert.

Seal water shall be separately fed to equipment in the pasteurised and unpasteurised sides of the evaporator. A common header tank may be used provided it is located to ensure back flow to the tank cannot occur.

CIP piping shall not have a path between the pasteurised and unpasteurised areas, without an atmospheric break in the circuit (when on product). An exception is if the whole evaporator including preheater is brought up to pasteurising temperature at the completion of the CIP, in order to sanitise the unit.

## **26.10 Holding Section for Preheat and Concentrate Pasteurisers**

### **26.10.1 General**

The holding section provides the means of ensuring that the dairy material, in continuous flow, is held at not less than the pasteurising temperature for not less than the specified time (as defined in section 11.2 of this Code).

There shall be a designated holding section for which the minimum holding time and temperature is nominated. The holding section shall be in the form of a holding tube in which the minimum residence time can be measured and the minimum temperature can be measured.

### **26.10.2 Holding tubes**

Where used, holding tubes shall comply with section 18, "Holding Tube" of this Code.

The required holding times for dairy material at these temperatures can be obtained from section 11.2.

### **26.11 Flow Diversion or Stopping System**

When the pasteurisation has failed there shall be a diversion or stopping system, to stop forward flow. Two options are possible:

either

Flow Diversion

- two single seat valves diverting the flow, as per section 19, “Diversion System” of this Code refer to first diagram in section 26 for evaporators and refer to third diagram in section 26 for concentrate systems;

or

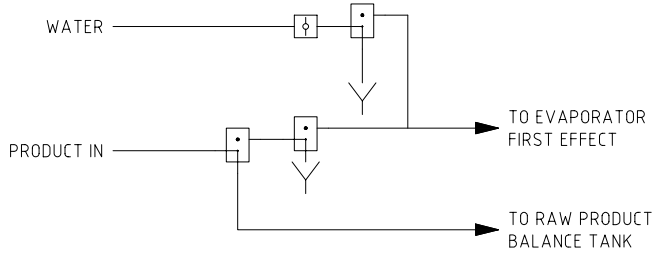
Flow Stopping

- where flow can be stopped ie as opposed to diverting, a valve is closed, or pump shut down, and the product route changed, see second diagram below.

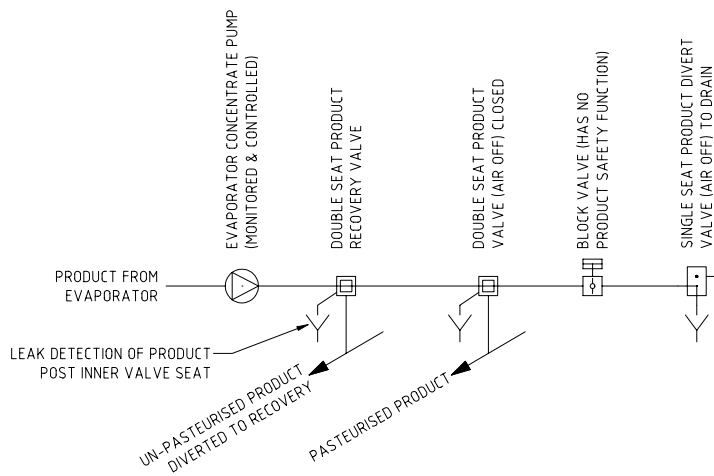
Once the evaporator is emptied out to recovery CIP shall be carried out.

If flow diversion at the evaporator preheater occurs, a potable water flush through the evaporator may be required to prevent burn-on. See first diagram below.

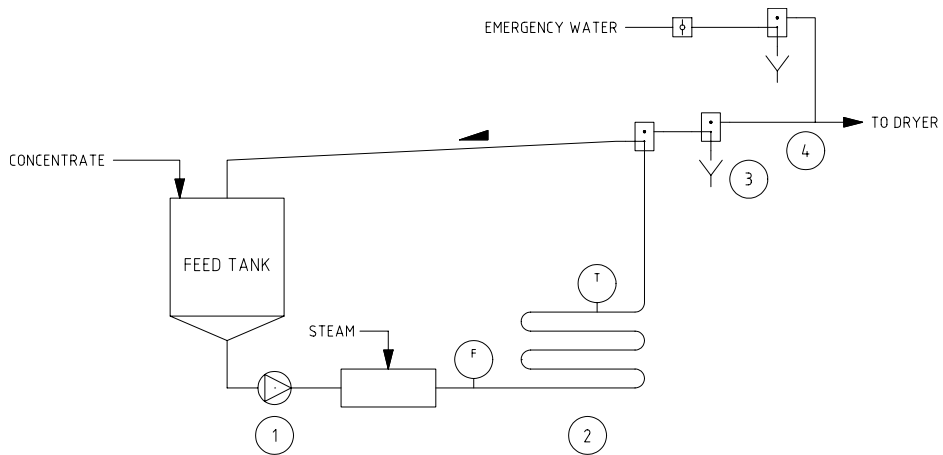
**Diagram: Flow Diversion for Evaporators**



**Diagram: Flow Stopping**



**Diagram: Flow Diversion for Concentrate Systems**



- NOTES**
1. TIMING PUMP OR FLOW CONTROL
  2. PASTEURISATION SECTION
  3. PRODUCT DIVERT VALVES
  4. WATER DIVERT VALVES

For an evaporator preheat pasteuriser, it is possible to allow concentrate to accumulate in the last effect vessel. This feature can be used to accumulate concentrate while the destination route is changed. When a diversion is required the discharge pump is stopped. (This is considered equivalent to the flow diversion requirements of section 19, "Diversion System".) A new destination is then set up (by flow plate or double seat valves) to receive unpasteurised product.

#### **26.12 CIP after Contamination with Unpasteurised Product**

For an evaporator with a flow stopping or diversion system after the evaporator, a section of the evaporator will become the outlet path for the unpasteurised dairy material.

In this case there shall be a re-sanitation of the affected areas.

To achieve re-sanitation a normal caustic and acid CIP will be sufficient, provided CIP parameters of pH>12, pH<2, at a minimum temperature of 60°C are achieved.

#### **26.13 Filter or Centrifuge**

When the dairy material has not been previously filtered or centrifuged to remove particulate matter, or where the dairy material has been handled in a manner that would allow it to become re-contaminated with particulate matter (e.g. after road transport, reprocessing, addition of re-melt or additives), the pasteuriser shall have a filter or centrifuge located before the final heating section. Particulate matter can protect micro-organisms from receiving the specified heat treatment

Filters shall have a maximum pore size of 200 µm, 500 µm, or 1000 µm in order to meet the respective maximum particle size limits described in section 2 and Table in 2.4.4 of this code. Where a centrifuge is used the time temperature requirements specified for a 200 µm filter shall apply.

#### **26.14 Vapour-Liquid Separation Vessel and Condenser within Evaporator**

Vapours and steam may be condensed either by direct contact (spray) condenser, or by indirect methods.

- Direct condensers shall use only potable water, or will be fitted with a level switch to ensure no condenser water floods into pasteurised product area. (see first diagram in section 26)
- Indirect condensers may use potable or non-potable water.

The vapour-liquid separation vessel and condenser shall be accessible for inspection and cleaning.

Any direct steam injection in these vessels shall comply with the requirements in section 14, "Heat Exchanger" of this Code.

Vacuum is created with the aid of a vacuum pump or ejector which removes the non condensables and by the condenser condensing the vapours and steam.

Vapours and steam are condensed using cold water. This shall be achieved:

either

- directly by direct contact with cold water sprayed into the condenser;

or

- indirectly by passing cold water through condenser pipes or plates.

The cooling media quality is seldom of potable quality, requiring the need for measures to avoid contamination. A similar situation exists with non-pasteurised product in a preheater section (refer to section 26.7, "Preheaters Internal in the Evaporator").

## 27 Control Systems

### 27.1 Diversion System

The pasteurisers shall have a flow diversion system or stopping system to ensure that no unpasteurised dairy material goes into the forward flow line.

The flow diversion system shall comply with section 19, "Diversion System" of this document.

For the flow stopping system, the operation of the evaporator pump shall be controlled in place of the divert valves. The control monitoring and recording system shall be as in section 19 with the divert valves being replaced by the evaporator pump.

### 27.2 Cross Contamination Control System

The pasteurisers shall have effective monitoring and recording for equipment used to prevent cross contamination referred to in section 26.9 of this document, including monitoring the position of CIP or product valves and vacuum pumps.

#### *Commentary*

*Monitoring requirements are minimised if the divert point is post the evaporator, or directly after the concentrate heater.*

### 27.3 Data Recording System

The data recording system shall comply with sections 5, "Data Collection and Recording System" and 21, "Data Recording System" of this document.

### 27.4 Computer Control Systems

Computer control systems shall comply with section 4, "Computer Control Systems" of this document.

### **27.5 Testing and Calibration**

Instrumentation control systems, computer programmes and safety features shall be accessible and able to be tested, calibrated and examined. Testing and calibration programmes shall comply with section 7, “Testing and Calibration” of this document.

### **27.6 Critical Parameter Security**

Critical control set points shall be controlled to prevent unauthorised alterations. Control systems and procedures for making alterations shall comply with section 6, “Critical Parameter Security” of this document.

## 28 Appendix 1: Pasteuriser Logging System Event Report

Pasteuriser Logging System Event Report								
System: 1								
From: 31-Jul-1995 08:00:00			To: 01-Aug-1995 08:00:00					
Date	Time	Sec	Mode	Tag	Event Description	Actual	Limit	Units
31-Jul-95	10:22:01	On	Water		Water: Start			
31-Jul-95	10:23:57	On	Water	T1VD2519	Primary Divert Valve: Forward			
31-Jul-95	10:24:02	On	Water	T1VD2520	Secondary Divert Valve: Forward			
31-Jul-95	10:24:12	On	Water	T1VD2518	Recycle Valve: Forward			
31-Jul-95	10:24:20	On	Water	T1VD2518	Recycle Valve: Recycle			
31-Jul-95	10:24:21	On	Water	T1VD2519	Primary Divert Valve: Diverted			
31-Jul-95	10:24:21	On	Water	T1VD2520	Secondary Divert Valve: Diverted			
31-Jul-95	10:26:01	On	Water	T1VD2519	Primary Divert Valve: Forward			
31-Jul-95	10:26:06	On	Water	T1VD2520	Secondary Divert Valve: Forward			
31-Jul-95	10:26:06	On	Water	T1VD2519	Primary Divert valve: Faulted			
31-Jul-95	10:26:07	On	Water	T1VD2519	Primary Divert Valve: Ok			
31-Jul-95	10:26:16	On	Water	T1VD2518	Recycle Valve: Forward			
31-Jul-95	11:15:17	On	Product		Water: Stop			
31-Jul-95	11:15:17	On	Product		Production: Start			
31-Jul-95	11:15:17	On	Product	T1TI2590	Pasteurising Temp: Recovered	73	71.8	Deg C
31-Jul-95	11:15:18	On	Product	T1PI2591	Differential Press Switch 1: Recovered			
31-Jul-95	11:19:23	On	Product	T1VD2518	Recycle Valve: Recycle			
31-Jul-95	11:19:24	On	Product	T1VD2519	Primary Divert Valve: Diverted			
31-Jul-95	11:19:24	On	Product	T1VD2520	Secondary Divert Valve: Diverted			
31-Jul-95	11:19:28	On	Product	T1PI2591	Differential Press Switch 1: Low			
31-Jul-95	11:19:29	On	Product	T1FI2585	Pasteurising Flow: High	88	84	m3/hr
31-Jul-95	11:19:37	On	Product	T1TI2590	Pasteurising Temp: Low	70.6	71.8	Deg C



31-Jul-95	11:19:45	On	Product	T1FI2585	Pasteurising Flow: Recovered	79	84	m3/hr
31-Jul-95	11:44:42	On	Off		Production: Stop			
31-Jul-95	15:39:29	On	Water		Water: Start			
31-Jul-95	15:41:12	On	Water	T1VD2519	Primary Divert Valve: Forward			
31-Jul-95	15:41:17	On	Water	T1VD2520	Secondary Divert Valve: Forward			
31-Jul-95	15:41:30	On	Water	T1VD2519	Primary Divert Valve: Diverted			
31-Jul-95	15:41:30	On	Water	T1VD2520	Secondary Divert Valve: Diverted			
31-Jul-95	15:43:35	On	Water	T1VD2519	Primary Divert Valve: Forward			
31-Jul-95	15:43:40	On	Water	T1VD2520	Secondary Divert Valve: Forward			
31-Jul-95	15:43:40	On	Water	T1VD2519	Primary Divert Valve: Faulted			
31-Jul-95	15:43:41	On	Water	T1VD2519	Primary Divert Valve: Ok			
31-Jul-95	15:43:50	On	Water	T1VD2518	Recycle Valve: Forward			
31-Jul-95	15:55:30	On	Product		Water: Stop			
31-Jul-95	15:55:30	On	Product		Production: Start			
31-Jul-95	15:55:30	On	Product	T1TI2590	Pasteurising Temp: Recovered	73.5	71.8	Deg C
31-Jul-95	15:55:31	On	Product	T1PI2591	Differential Press Switch 1: Recovered			
31-Jul-95	15:56:46	On	Water		Water: Start			
31-Jul-95	15:56:46	On	Water		Production: Stop			
31-Jul-95	15:58:41	On	Product		Water: Stop			
31-Jul-95	15:58:41	On	Product		Production: Start			
31-Jul-95	15:59:58	On	Product	T1VD2519	Primary Divert Valve: Diverted			
31-Jul-95	15:59:58	On	Product	T1VD2520	Secondary Divert Valve: Diverted			
31-Jul-95	15:59:58	On	Product	T1VD2518	Recycle Valve: Recycle			
31-Jul-95	16:00:02	On	Product	T1PI2591	Differential Press Switch 1: Low			
31-Jul-95	16:00:03	On	Water		Water: Start			
31-Jul-95	16:00:03	On	Water		Production: Stop			
31-Jul-95	16:01:49	on	Water	T1VD2519	Primary Divert Valve: Forward			
31-Jul-95	16:01:54	On	Water	T1VD2520	Secondary Divert Valve: Forward			
31-Jul-95	16:01:54	On	Water	T1VD2519	Primary Divert Valve: Faulted			
31-Jul-95	16:01:55	On	Water	T1VD2519	Primary Divert Valve: Ok			

31-Jul-95	16:02:04	On	Water	T1VD2518	Recycle Valve: Forward			
31-Jul-95	17:13:34	On	Product		Water: Stop			
31-Jul-95	17:13:34	On	Product		Production: Start			
31-Jul-95	17:13:34	On	Product	T1PI2591	Differential Press Switch 1: Recovered			
31-Jul-95	17:48:18	On	Product	T1TI2590	Pasteurising Temp: Low	71.6	71.8	Deg C
31-Jul-95	17:48:21	On	Product	T1VD2518	Recycle Valve: Recycle			
31-Jul-95	17:48:22	On	Product	T1TI2590	Pasteurising Temp: Recovered	72.6	71.8	Deg C
31-Jul-95	17:48:22	On	Product	T1VD2519	Primary Divert Valve: Diverted			
31-Jul-95	17:48:22	On	Product	T1VD2520	Secondary Divert Valve: Diverted			
31-Jul-95	17:48:25	On	Product	T1PI2591	Differential Press Switch 1: Low			
31-Jul-95	17:48:27	On	Product	T1FI2585	Pasteurising Flow: High	88	84	m3/hr
31-Jul-95	17:48:38	On	Product	T1FI2585	Pasteurising Flow: Recovered	81	84	m3/hr
31-Jul-95	17:48:40	On	Product	T1TI2590	Pasteurising Temp: Low	71.8	71.8	Deg C
31-Jul-95	17:49:01	On	Product	T1TI2590	Pasteurising Temp: Recovered	73.7	71.9	Deg C
31-Jul-95	17:49:05	On	Product	T1TI2590	Pasteurising Temp: Low	68.6	71.9	Deg C
31-Jul-95	17:49:22	On	Product	T1TI2590	Pasteurising Temp: Recovered	73.4	71.9	Deg C
31-Jul-95	17:49:28	On	Product	T1TI2590	Pasteurising Temp: Low	65.4	71.9	Deg C
31-Jul-95	17:50:19	On	Product	T1VD2519	Primary Divert Valve: Forward			
31-Jul-95	17:50:20	On	Product	T1TI2590	Pasteurising Temp: Recovered	72.4	71.8	Deg C
31-Jul-95	17:50:24	On	Product	T1VD2520	Secondary Divert Valve: Forward			
31-Jul-95	17:50:26	On	Product	T1PI2591	Differential Press Switch 1: Recovered			
31-Jul-95	17:50:35	On	Product	T1VD2518	Recycle Valve: Forward			
31-Jul-95	17:50:53	On	Product	T1VD2518	Recycle Valve: Recycle			