

Australian/New Zealand Standard™

**Guide to the cleaning-in-place
of dairy factory equipment**

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Australian Chemical Specialties Manufacturers Association
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Australian Food Council
Dairy Industry Association of Australia
Dairy Industry Authority of Western Australia
Department of Primary Industries, Queensland
Detergent & Sanitizers Manufacturers Co-Op Group, New Zealand
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of dairy factory equipment**

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee FT/9, Dairy Detergents and Sanitizers, to supersede AS 2541—1982.

This Standard is one of a number of Standards dealing with dairy detergents and sanitizers. This Standard should be read in conjunction with AS 1162—1991, *Cleaning and sanitizing dairy factory equipment* and AS 1536—1991, *Cleaning and sanitizing milking equipment* and may also require reference to the product specifications.

The objective of this revision is—

- (a) to maintain the established Standard which specifies guiding principles;
- (b) to present recommended practices for the cleaning of dairy factory equipment by means of cleaning-in-place (CIP) procedures;
- (c) to incorporate the latest developments in the technology such as oxidizing agents and enzymes that are used in a CIP system to the Standard; and
- (d) to introduce some minor changes.

This Standard sets out general principles upon which the techniques of cleaning-in-place (CIP) of dairy factory equipment are based, by drawing together into one document an explanation of the numerous factors which practical experience has shown to be of importance in the successful employment of CIP procedures in dairy factories. Such an integrated explanation is not known to exist elsewhere, even though the individual elements involved in the total system are well enough understood.

The term ‘informative’ has been used in this Standard to define the application of the appendix to which it applies. An ‘informative’ appendix is only for information and guidance.

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CONTENTS

	<i>Page</i>
FOREWORD	5
 SECTION 1 SCOPE AND PRINCIPLES	
1.1 SCOPE	6
1.2 REFERENCED DOCUMENTS	6
1.3 GENERAL CONSIDERATION	6
1.4 SOILS	7
1.5 MECHANISMS OF SOIL REMOVAL	7
1.6 SANITIZING	10
1.7 CIP CYCLES	11
 SECTION 2 DESIGN AND INSTALLATION	
2.1 GENERAL	14
2.2 SINGLE USE OR RE-USE OF DETERGENT SOLUTIONS	14
2.3 GENERAL FACTORS AFFECTING DESIGN AND EFFICIENCY	14
2.4 SURFACES	14
2.5 PIPELINE ASSEMBLY AND SUPPORT	15
2.6 PLACEMENT OF SPRAY HEADS	15
2.7 DISMANTLING AND INSPECTION	15
2.8 DEAD SPOTS	15
2.9 PUMPING RATES AND PUMP SIZING	16
2.10 DETERGENT CYCLES, TANK NUMBERS, AND CAPACITIES	16
2.11 DEGREE OF PROGRAMMING	17
2.12 SERVICES REQUIRED	17
2.13 DETERGENCY	18
 SECTION 3 PERFORMANCE TESTING	
3.1 GENERAL	20
3.2 QUALITY OF CLEANING	20
3.3 PRODUCT QUALITY	20
3.4 EQUIPMENT SURFACE CONDITION	20
3.5 WATER QUALITY	21
3.6 MONITORING EFFECTIVENESS OF CLEANING	21
3.7 TROUBLESHOOTING	22
3.8 MONITORING MECHANICAL OPERATION	22
3.9 MONITORING SYSTEM OPERATION	22
3.10 MAINTAINING EQUIPMENT OPERATION	22
 SECTION 4 EFFLUENT DISPOSAL	
4.1 GENERAL	23
4.2 EMPTYING OF PRODUCT SYSTEM	23
4.3 PRE-RINSE CYCLE	23
4.4 DETERGENT USE	23
4.5 ECONOMIC DISPOSAL	23
4.6 TRAINING	23

APPENDICES

A	THE USE OF CHANGE PLATES OR HOOK-UP PLATES	24
B	INTERPRETATION AND TROUBLESHOOTING	28
C	MILK SOIL TYPES AND DETERGENT INGREDIENTS	30

FOREWORD

There would be few, if any, milk processing plants operating in Australia and New Zealand today in which cleaning-in-place (CIP) procedures are not practised on some of the equipment.

The expansion of the CIP technique from small beginnings to an almost universal, essential operation has occurred against a background of trial (and error) by many people, in many places, with minimal coordination, guidance or direction.

This Standard sets out what are believed to be the principles on which effective CIP should be based and it attempts, by means of examples, to illustrate the application of these principles to the practice of CIP.

It must be appreciated that although a number of principles can be determined and examined independently, combining these into a viable CIP system involves numerous parallel, but interdependent, functions which must always be considered together in their relationship to each other and to the whole. If this is not done, the results will usually be unnecessary expense, frustration in operations and, worst of all, unsatisfactory hygiene.

It is the purpose of this Standard to provide equipment manufacturers, dairy factory managers, factory engineers and technical staff with information which, when assimilated, will materially assist in improving the operation of CIP systems. The Committee recognizes the need for operator training and this Standard may be used as a basis for this purpose.

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard**Guide to the cleaning-in-place of dairy factory equipment**

SECTION 1 SCOPE AND PRINCIPLES

1.1 SCOPE This Standard sets out guiding principles and presents recommended practices for the cleaning of dairy factory equipment by means of cleaning-in-place (CIP) procedures. It applies to all dairy factory cleaning operations where equipment is cleaned by the use of circulating liquids, in contrast to being physically scrubbed by manual exertion. For specific methods of cleaning all items of equipment, reference should be made to AS 1162.

1.2 REFERENCED DOCUMENTS The following documents are referred to in this Standard:

AS

1162 Cleaning and sanitizing dairy factory equipment

2919 Industrial clothing

AS/NZS

1337 Eye protectors for industrial applications

2161 Occupational protective gloves (series)

2210 Occupational protective footwear (series)

1.3 GENERAL CONSIDERATION In any system, soil is removed from the surfaces as the result of being dissolved or degraded through chemical reactions and by mechanical action from the circulating CIP solution. It is then removed by the circulating liquid, which has to maintain the soil in solution or suspension to avoid redepositing it onto the cleaned surfaces.

The following factors are fundamental to an appreciation of CIP in dairying equipment. These factors are supported by consideration of temperature, time, flow volumes, flow rates (see Clauses 1.5.4 to 1.5.6) and detergent concentrations:

- (a) It is possible, with the help of engineering, to achieve solution contact with surfaces that would otherwise be, for practical purposes, inaccessible.
- (b) Programmed, identical cleaning cycles can ensure standard application of various cleaning regimes.
- (c) Labour can be more expensive and less consistent than machinery for equipment cleaning.
- (d) The physically more extensive the circuit, the more reason there is to use CIP.
- (e) CIP is a technology and as such has inherent requirements, and limitations, which must be taken into account when determining its position in a production function.
- (f) There is an elapsed time required for a CIP operation. This may, through careful design, and close automatic sequence control, be reduced to a minimum for a given circuit, but it cannot be reduced below that which is required to remove soils from the system. Since all reactions require time, it is the slowest of these reactions which basically determines how quickly a system can be cleaned.

1.4 SOILS A soil is the milk or dairy product residue which remains on the product-contact surfaces of the equipment. Different methods of cleaning are required for various items of plant, depending on the type of soil to be removed; for example—

- (a) deposits from cold milk;
- (b) deposits produced when milk is moderately heated, such as in HTST pasteurizers, heat exchangers, preheaters for evaporators;
- (c) deposits produced when milk is given more severe heat treatment such as in UHT pasteurizers, vacuators; and
- (d) deposits produced from manufactured products such as concentrated milk, cream and ice cream.

These soils contain various proportions of fat, protein, lactose and minerals, and depending on the proportions of each substrate, may be removed by various combinations of detergent systems. Consequently different combinations of detergent systems are used to clean the soils from the plant.

1.5 MECHANISMS OF SOIL REMOVAL

1.5.1 General Energy must be applied to remove a soil from a surface. This energy can be in three forms, viz.—

- (a) *mechanical*—such as turbulent solutions or brushing;
- (b) *thermal*—in heated cleaning solution; and
- (c) *chemical*—in chemicals included in detergents.

The energy from these three sources is to some extent interchangeable; for example, increasing the temperature of a solution may permit a lower detergent concentration to be used, or may enable a decrease in time (or both).

1.5.2 Chemical mechanisms Some of the chemical mechanisms of soil removal are as follows:

- (a) *Dissolving*—the soluble portions of the soil are dissolved in the medium being employed.
- (b) *Wetting*—surfactants (anionic, cationic, nonionic or amphoteric) decrease the surface tension of the medium, improving the penetration of the detergent solution into the soil particles.
- (c) *Emulsification*—a reduction in the fat particle size, disperses and suspends them in a physical condition which will minimize the possibility of redeposition.
- (d) *Peptization*—the breakdown of protein residues into smaller, often soluble, residues.
- (e) *Saponification*—the alkaline portions of the chemical react with fats to increase the water solubility.
- (f) *Deflocculation*—the inclusion of specific chemicals into the formulations increases the ability of the medium to disperse and suspend the physically removed soil particles, and prevent them from redepositing on the equipment surfaces.
- (g) *Sequestration*—the inclusion of sequestering agents in the detergent causes the inorganic cations like calcium, iron, magnesium ions to be chemically bonded, thus minimizing the formation of milkstone and waterscale.
- (h) *Oxidation*—may be included in cleaners to oxidize and break down the organic components of the soil.
- (i) *Enzymes*—enzymes which attack the organic components may be incorporated to break down soil matrices.

1.5.3 Physical factors in soil removal The important physical factors which determine the effectiveness of the cleaning solution are its temperature, time of contact with the soil and flow rate through the equipment. These are discussed in Clauses 1.5.4 to 1.5.6.

1.5.4 Temperature Temperature of the cleaning solution is the first major physical factor in CIP technology, the significance and implications of which are not always appreciated. It is the crucial factor in controlling chemical reaction rates in detergent solutions, and hence has a considerable influence on circulation times. The solution temperature selected must also be compatible with the equipment being cleaned. These can act in opposition to each other, particularly if the soil types on the surfaces of different parts of the circulation system differ widely. In this case it is general practice to set the cleaning conditions to clean the most tenacious soil. However, it is important to be sure that equipment unsuitable for treatment by these conditions has not been incorporated into the circuit.

For example, incorporation of a heavily soiled piece of equipment (a vacreator or pasteurizer) which normally requires prolonged circulation at particular high temperature, with a lightly soiled vessel (a cold milk holding tank) with the cover open, will certainly result in the lightly soiled vessel becoming liable to stress damage, due either to excessive expansion or heat storage in the insulation.

Therefore preliminary planning is of considerable importance to allow consideration of these opposing functions and to make adequate provision to overcome them if and when they occur.

Another factor to be borne in mind is the realization that whenever a CIP solution is first circulated through a cold system there is a considerable loss of heat to the equipment being circulated, with a consequent drop in temperature in the circulating fluid. In a major system this may be as much as 15°C to 20°C, and it is apparent that there will consequently be a dramatic drop in detergent activity. Hence, the requirement for a source of heat to maintain the circulating solution at the set temperature required. Since the circulation times for CIP are based on periods at a specified temperature (which is usually the temperature to which solutions are heated prior to circulation), it follows that circulation times will be prolonged to an unnecessary degree if inadequate heat 'make-up' facilities are provided. Circulation liquid temperature recovery in excess of 5 min could generally be considered suspect since this will usually extend circulation cycles to over 30 min on even the most lightly soiled equipment—this is time, heat and power wasted.

1.5.5 Time There is an elapsed time required for a CIP operation. This may, through careful design, and close automatic sequence control, be reduced to a minimum for a given circuit, but it cannot be reduced below that which is required to remove soils from the system.

Removal of soils in CIP systems results from reactions which are physical, chemical and mechanical in nature. Since all reactions require time, it is the slowest of these which determines how quickly a system can be cleaned.

The differing factors such as soil load, temperature requirements make it impossible to provide one single situation to cover all requirements. However, it is possible to provide information on cycle requirements as a guide to the likely times involved for a majority of soiled circuits; for example—

Step 1

Pre-rinse	}	 2 min to 3 min.
Pre-detergent rinse		

NOTE: This can be the most important step of all CIP cleaning, as the amount of initial soil removed depends on rinse time.

Step II

Circulate detergent (after desired temperature is reached) 10 min to 60 min.

Step III

Post-detergent rinse 2 min to 3 min.

Step IV

Sanitizing rinse 2 min to 3 min.

NOTE: There may be occasions, e.g. intermediate cleans batch processes, where circulation times may be reduced for a series of such cleans. However the final clean at the end of an operational period calls for longer cycles such as the above.

These are the basic steps in *any* cleaning-in-place operation. The times stated take no account of any necessary drain periods, heating (recovery times), set-up time, possible hand cleaning of some parts before circulation starts, need to circulate more than one type of detergent, or return to operation.

NOTE: For details of applications to specific circuits, refer to AS 1162.

In practice it is unlikely that any circuit can be cleaned consistently in less than 40 min elapsed time, and this may under particular circumstances extend to as much as 240 min. Unless this elapsed time requirement is catered for in production scheduling, there will inevitably be a decline in the effectiveness and quality of cleaning.

1.5.6 Flow volume and flow rates Flow volume and flow rates are the third major factors in CIP technology and have the functions of ensuring that kinetic energy is available at the solution/soil interface, and of removing dissolved or otherwise chemically degraded soils from the area being cleaned.

In order fully to appreciate the significance of this part of the CIP operation, the difference between two types of circuitry must be considered. For want of better names these are frequently described as ‘closed’ and ‘open’.

A *closed circuit* is one in which solution flow starts from and returns to the same solution tank with only the delivery pump from the tank being used to circulate the entire system. Characteristics of this type of circuit are as follows:

- (a) The system is full of liquid and hence is restricted to pipelines and those small volume pieces of equipment which are equivalent to pipelines in their flow characteristics, e.g. plate heat exchangers.
- (b) The foam level of the detergent may need to be ‘low’.
- (c) Apart from initial temperature drop, heat losses throughout circulation are at a minimum.

An *open circuit* is one which contains pieces of equipment which are impractical to clean by filling with solution. This may be for economic reasons (volume of water, quantity of detergent, and heat requirement), excessive time requirement, inability to provide temperature and/or flow rates required or circuitry arrangements. Characteristics of this type of circuit are as follows:

- (i) Passage of solutions through spray heads, jets or nozzles.
- (ii) Flowing thin films of liquid over extensive surface areas.
- (iii) Considerable temperature loss during the whole time of circulation.
- (iv) Necessity for return pumps, hence rates must be balanced to avoid starving or flooding.
- (v) Low foam detergents are generally preferred.
- (vi) Burst rinsing may be applied to economize on water usage.