

FAO ANIMAL PRODUCTION AND HEALTH PAPER 53

Slaughterhouse cleaning and sanitation

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PREFACE

Any manual or guidelines on this topic will cover a number of subjects which have to be adjusted to the actual conditions of the country which may differ from the most simple countryside slaughter facilities to the most modern slaughterhouses. Machines and equipment may or may not exist in small slaughterhouses while modern slaughterhouses may have automatic equipment and machines.

Sanitation is the act or process of providing adequately hygienic conditions to ensure a safe, sound, wholesome product fit for human consumption and covers hygienic precautions regarding personal hygiene, process hygiene and cleaning and disinfection. Sanitation may also signify disinfection, but in this publication sanitation will be used according to the definition given above and disinfection as a reduction of the number of microorganisms.

Guidelines concerning cleaning and sanitation can be either theoretical or practical but here they will comprise a theoretical model for cleaning and disinfection and some practical examples for cleaning and disinfection of different kinds of slaughterhouses.

Furthermore the manual will contain a few guidelines concerning personal hygiene and process hygiene and give examples of the connection between personal hygiene, process hygiene and cleaning and disinfection.

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1. INTRODUCTION

Cleaning and sanitation are an integral part of slaughtering and handling of meat and should already be taken into consideration

at the planning and construction stage of slaughter facilities.

1.1 Actual conditions

Cleaning and sanitation in slaughterhouses in developing countries will be difficult to apply as a single programme because developing countries may differ concerning:

- **supplies of water**
- **supplies of energy**
- **supplies of machines, equipment etc.**
- **supplies of detergents and disinfectants**
- **cultural traditions**
- **religious traditions**

- **climate**
- **requirements for buildings**
- **possibilities for employment of trained staff**
- **organization of slaughtering**
- **types of animals slaughtered**

In cases where the supplies for cleaning are insufficient, the cleaning programme has to be planned accordingly. Even processing should be planned according to the cleaning supplies available. If sufficient supplies are available, the cleaning programme may be planned according to buildings, processing equipment, required hygiene level, economy etc.

Frequently there will be cultural and religious traditions concerning hygiene and cleaning, and even processing, which

will differ from area to area. Traditions are based on actual conditions and may when evaluated - need some adjustment to assure the required level of hygiene. These local traditions may not be described anywhere and therefore local authorities, aware of these traditions, will be responsible in assuring the required hygiene level. The combination of this knowledge may result in solutions other than those used in developed countries. These solutions may already exist but have not yet been described.

1.2 Organization

The organization of the meat plant may also depend on local traditions, making it impossible to give advice covering all situations.

In smaller public slaughterhouses, owned by the municipalities, there will often be a manager and no specific staff (see Fig. 1), slaughterings being carried out by local butchers and their

working teams. In these situations it will be difficult to give any training to workers on hygiene and cleaning. Slaughterhouses of this type are difficult to manage because there may be several working teams in one day with varied experience in hygiene slaughtering and working conditions (see 2.3).

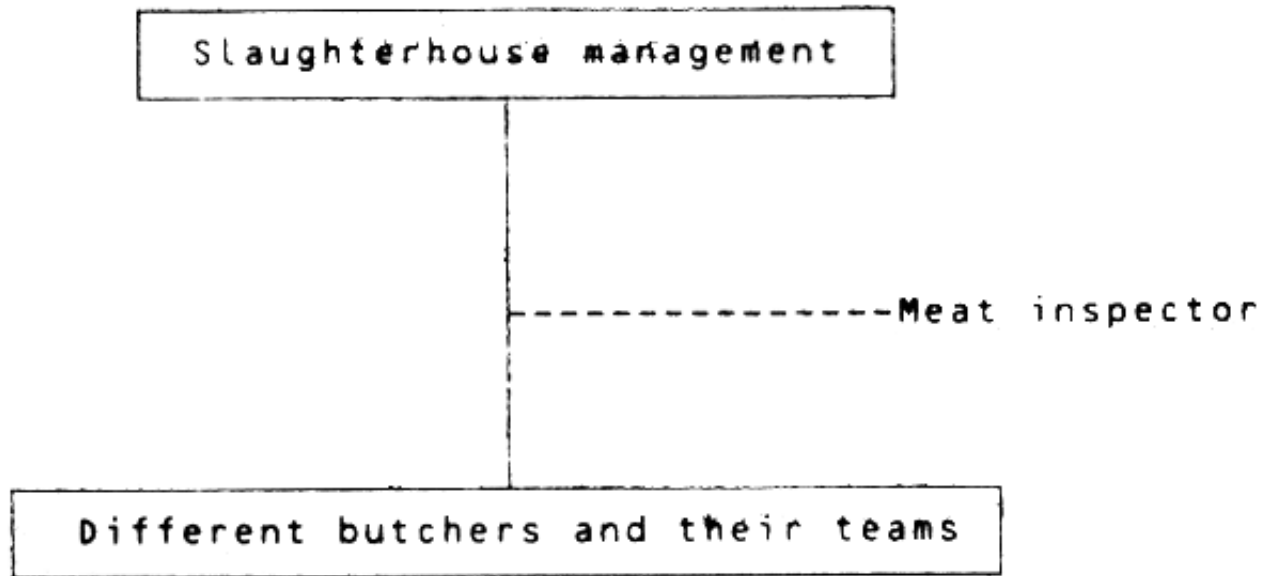


Fig.1. Organization of smaller municipally-owned slaughterhouses

Large slaughterhouses have permanent staff which perform all kinds of work. When the staff are permanent, they can receive some training in process hygiene, personal hygiene and cleaning and disinfection.

The slaughterhouses/slaughter facilities should be supervised by government or local authorities. It is recommended that a permanent staff be selected and that they work under a qualified manager. There should also be a meat inspector - independent of the manager and economic interests - who is responsible to the local or governmental veterinary or health authorities.

Ideally the staff should consist of two groups (see Fig. 2), consisting of a slaughtering team and a cleaning team.

Organization of the slaughtering team will not be described in this publication.

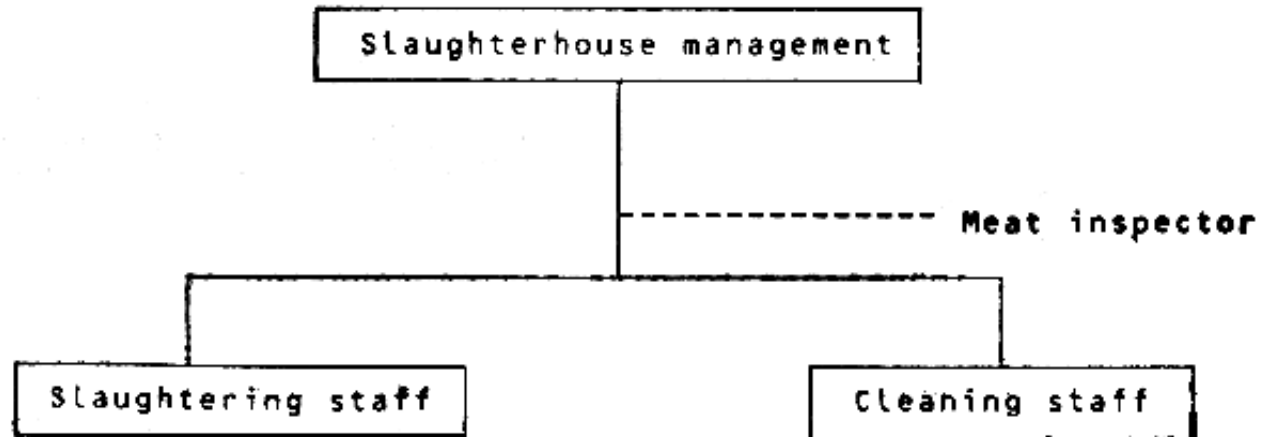


Fig. 2. Organization of larger slaughterhouses with permanent staff

The cleaning team can operate during processing and during breaks etc. and the whole cleaning team should clean the entire

area after processing.

When the staff is organized as shown in Fig. 1 it will be possible to give the staff a basic knowledge in processing and cleaning hygiene (see 2.7). The staff may even be trained in practical procedures. However, this may be difficult to practise in smaller slaughterhouses.

Responsibility for specific duties should be clearly set out for all the staff. It may be advisable to give a few persons the main responsibility for specific tasks and let these persons delegate the responsibility for smaller duties to an individual.

1.3 Communication

When organized as in Fig. 1 communication may be a problem between the manager and the butchers and their teams. Even if organized as in Fig. 2, problems may arise in communication

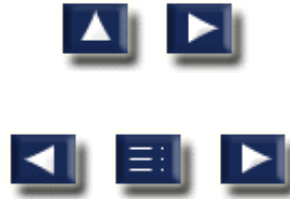
between the manager and the groups of staff.

Procedures must be established which will assure sufficient communication between the different groups. Some of this communication could be used for training purposes but it could also be of an informal character to ensure that everybody is sufficiently informed about the running of the slaughterhouse.

The problems which may arise concerning organization, communication and training will in principle be the same for rural slaughterhouses as for large exporting slaughterhouses, although the solution to these problems will be even more important when the staff is large.

The attainment of a good hygiene and cleaning standard depends on the knowledge of hygiene, processing and cleaning techniques, including personal hygiene. Furthermore, success will also depend on the ability to manage the staff regarding

these subjects.



2. HYGIENE

A well-planned, well-executed and controlled cleaning and sanitation programme for rooms, machines and equipment is very important to achieve a hygienic standard. Cleaning and sanitation alone, however, will not assure a hygienic standard in production where process hygiene as well as personal hygiene are important factors.

Well-planned working routines may assure a better cleaning

standard during processing. For example, cleaning during processing, removal of solid waste and sufficient space in processing rooms are factors which facilitate cleaning.

Adequate personal hygiene assures the overall cleaning process. Deterioration of the cleaning standard may occur if microorganisms are transmitted to well-cleaned surfaces from unwashed hands before processing starts.

Neither process hygiene, personal hygiene nor cleaning and sanitation alone can assure a sufficient hygienic standard but together, if carried out in an optimal manner, they will guarantee a complete hygienic standard.

2.1 Process hygiene

It is impossible to give an adequate definition of process hygiene because the critical points will vary, depending on:

- **processing**
- **processing buildings (site, size, buildings)**
- **equipment available**
- **permanent or non-permanent personnel (working routines, training)**
- **climatic conditions**
- **sanitary facilities**
- **water and energy supplies**
- **liquid and solid waste disposal**

2.1.1. Site of buildings for slaughtering and processing

The slaughterhouse should be situated away from residential areas. Access for animals - either by road, rail and/or stock route - must be assured. The slaughterhouse should be located in areas where flooding is impossible.

An abundant supply of potable water as well as adequate facilities for treatment and disposal is important.

The land acquired for the proposed slaughterhouse should be sufficient to permit future expansion as overcrowding of facilities may give sanitation problems.

Where the “slaughterhouse” is more or less an open slaughterplace, trees may provide some shade or even be used as a part of the structure. If the slaughterhouse consists of regular buildings the ground should be free of shubbery or vegetation in close proximity to the structure.

2.1.2 Size

There should be a reasonable relationship between the size of slaughter facilities and the number of animals to be killed.

Sufficient space for lairage and tripe and hide treatment is required. The space required for lairage will often depend on local and even climatic conditions. In specific areas it will only be possible to transport the animals in the dry season while slaughtering may only be carried out in the rainy season because of water requirements.

Sufficient space is required to dig pits for condemned animals, compost stacks, lavatories etc., and for disposal of liquid and solid waste.

2.1.3 Buildings / facilities

Buildings / facilities should be so constructed that clean and

unclean processes and products do not mix.

The floor must be hard, smooth and impervious, sloping sufficiently towards a drain thus allowing cleaning with water.

Walls, if any, may be made of local construction materials. In certain dry areas walls are not necessary. Materials, which can be cleaned by water, are recommended, e.g. stone, lava blocks, bricks or concrete.

Roofs, if any, may be constructed of materials available (tiles, corrugated iron, asbestos or aluminium).

Roofing is recommended:

- **to protect and allow the slaughter process to be independent of the weather**
- **to provide shade and keep down the internal temperature**

- **to enable the collection of rainwater in water tanks.**

For detailed planning and construction of slaughterhouses/ slaughter facilities reference is made to “Slaughterhouse and slaughterslab design and construction”, FAO Animal Production and Health Paper no. 9, by P.J. Eriksen, FAO, Rome, 1978 and “Guidelines on small slaughterhouses and meat hygiene for developing countries”, VPH/85.56 by I. Mann, WHO, Geneva, 1984.

2.2 Equipment

The main principle for equipment such as tables, hooks and machines, etc. should be that it is easy to dismantle or remove to facilitate cleaning and that it should be made of non-corrosive materials.

Essential for the hygienic handling of carcasses and meat is

equipment for hoisting the carcasses, when slaughtered. Hoists, when possible, should be preferred to working tables. Procedures assuring a periodical or continuous cleaning of hoists are recommended.

Cleaning and disinfection will often be complicated or impossible because of the complex construction of machines and when choosing and buying machines, hygienic production and possibilities for cleaning and disinfection must be considered.

2.3 Permanent or non-permanent personnel

Many large slaughterhouses have permanent personnel performing all work in the slaughterhouses. Organization will depend on the type of production. Where personnel is permanent, a few lessons regarding process hygiene, personal hygiene, and cleaning and disinfection may be given.

Ideally, personnel should be organized in a way that part of the staff is occupied with cleaning and disinfection. This group of personnel must be educated and trained especially in cleaning and disinfection procedures as well as general hygiene.

Where the slaughterhouse/slaughter facilities cover the need for slaughtering in big areas in developing countries, the slaughterhouse is often owned by municipalities and organized with a manager and no permanent staff. Slaughtering is done by local butchers and a team employed by these butchers and thus it will be difficult to give them sufficient education and training in hygiene.

It is therefore recommended that the manager of the slaughterhouse/slaughter facilities employ a team which is responsible for maintenance of a hygienic standard. This team should do some clearing and cleaning during slaughtering hours or instruct the butchers and workers to do this during and after

slaughtering. This team will be responsible for cleaning and disinfection at the end of the working day and in maintaining the hygienic standard.

2.4 Climatic conditions

Climatic conditions will influence hygiene and processing. Different precautions should be taken depending on the climate in the area as they are not the same in a temperate as in a tropical climate.

Requirements regarding buildings, (see 2.1) processing (see 2.7) and working vary according to climatic conditions.

In a tropical climate it will often be necessary to start slaughtering during the night hours before sunrise and distribute the meat for sale in the morning hours.

Slaughterhouses/slaughter facilities in these areas may be very

weather-dependent (outdoor temperature, rainy/ dry periods, water supplies etc.). The floor and wall surfaces etc. in this kind of slaughterhouses will in dry periods be allowed to dry completely thus assuring that no microorganisms will multiply. If water supplies are insufficient, e.g. in dry periods, surfaces should be scraped clean and then sun-dried if possible. This procedure will presumably give the same or even better hygienic results than a cleaning process with insufficient amounts of water.

In large, commercial slaughterhouses in tropical climates the working routines will be the same as those in large slaughterhouses in temperate climates. For this type of slaughterhouses, work will be almost independent of weather conditions.

2.5 Sanitary facilities

Water points, hoses, sterilizers for hand tools etc. and cleaning equipment must be provided in sufficient numbers. Where possible sterilizers should be supplied with hot water instead of chemical disinfectants.

Sanitary facilities must also include a sufficient number of toilets/latrines and arrangements for hand-washing or even possibilities for bathing (showering). These facilities must be kept clean and well maintained.

To avoid back-flow from toilets in case of flooding the toilet outlets must be separated from common waste water outlets.

Areas/rooms for resting and eating may be required assuring that food for the personnel and the carcasses/meat cannot be mixed.

2.6 Water and energy supplies

If sufficient water of drinking quality is available, it will be

possible to plan processing and cleaning procedures in a way which assures hygienic products. The water supply may be from the premises own well or from the community supply. Working routines should be planned to economize the consumption of water because of waste water disposal.

Energy supplies will be necessary if the slaughterhouse is more or less automatic. Energy supplies will also be necessary for automatic cleaning and could be provided through windmills, biogas production, fuel and electricity and water could also be heated by solar energy.

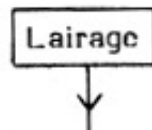
If water and energy supplies are sufficient it will be the responsibility of the management of the slaughterhouse to see that these supplies are used efficiently and that sufficient water and energy are used for hygienic purposes.

2.7 Processing

The elements of hygiene will differ depending on the type of processing. There will be significant differences between the hygiene standard required in a plant manufacturing meat products, which are sold as sliced, prepackaged meat products, and the hygienic standard required in a place where the animals are slaughtered.

The main hygiene principle in processing is that clean and unclean operations are efficiently separated. This requires a wellplanned plant layout, where the purpose of any structure should be to protect the products against unintended contamination.

Processing principles are shown in the following flow-diagram (Fig. 3).



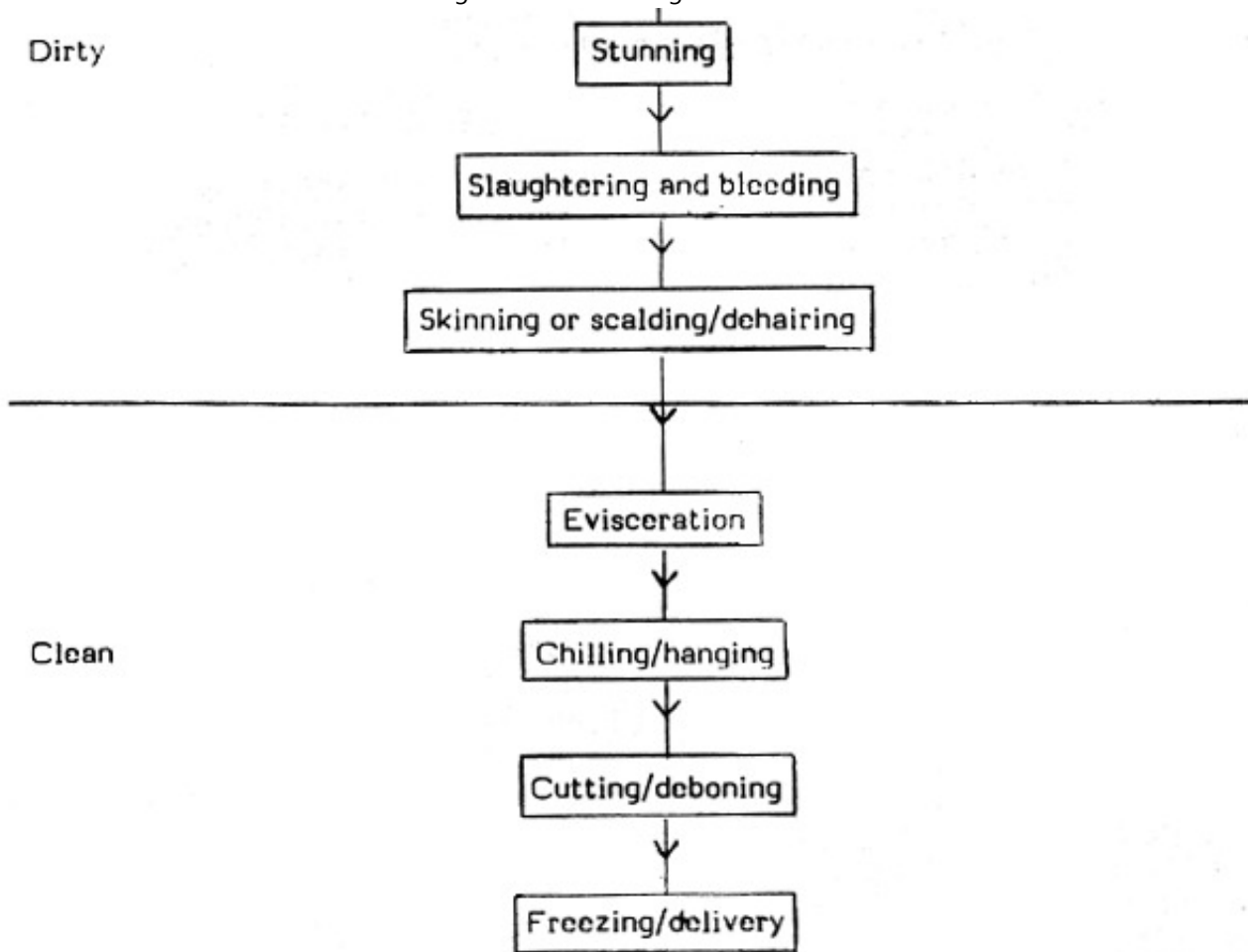


Fig. 3. Flow-diagram showing the principles in a slaughtering process. The subprocesses are divided in “dirty” and “clean” operations.

Hanging/chilling, cutting/deboning, and/or freezing depend on local conditions.

Lairage: there should be sufficient space and a sufficient supply of potable water for drinking purposes. A spraying system where the animals can be cleaned before entering the slaughterhouse is recommended, if sufficient water is available. The floor should be constructed of concrete and sloping towards drains in order to facilitate cleaning.

Regulations concerning feeding and watering of the animals before slaughter should be considered.

2.7.1. Stunning, slaughtering and bleeding

These processes must, if possible, be separated from the operations which follow. If the blood is not intended for use it should be drained away into a separate pit and should not be allowed to drain into the waste water. The animals should be hoisted to facilitate bleeding and decrease the risk of contamination of the carcasses.

This area should be constructed with a slope towards drains (ref. FAO 1978).

2.7.2 Scalding, skinning, dehairing or plucking

The process varies according to animal (poultry, pigs and cattle).

Skinning or dehairing may be carried out in a separate room/area or in the slaughtering place. However, it should be carried out separately from the evisceration process. The same principle

applies to plucking of poultry.

The unskinned/undehaired carcass must never enter the clean area, but as soon as possible after skinning, dehairing, or plucking, it must be hygienically transferred to the clean area (evisceration room/or area). It is important to handle the carcass carefully to minimize contamination.

To secure and improve cleanliness and efficiency hoists and overhead rails are required for the skinning/dehairing process. If hoists and overhead rails are not available, the carcasses should be kept above floor level by means of cradles. Procedures assuring cleaning of hoists, overhead rails and cradles should be established.

Special rooms/areas should be available for treatment of hides.

2.7.3 Evisceration

During the evisceration process care should be taken to minimize contamination. Special care must be taken to avoid damaging the intestines. Edible organs must be handled in a hygienic way (stored/ removed in separate containers etc.). Waste must be removed rapidly from the floor in the evisceration room/area.

A sufficient number of sterilizers for hand tools, knives, etc. must also be available in the evisceration area.

2.7.4 Chilling/hanging

Carcasses may be chilled or divided in halves or quarters and then distributed for sale as soon as possible. When chilling is carried out, there must be sufficient chilling capacity and space to assure sufficient chilling.

Carcasses can even be chilled when they are just hanging up and are air-dried, chilling being caused by evaporation.

2.7.5 Cutting /deboning

If cutting and/or deboning is carried out care must be taken to minimize contamination of the meat. The carcasses must be cut, preferably hanging or on surfaces (tables, cutting planks, chopping blocks), which are regularly cleaned. A sufficient amount of sterilizers must be available for cleaning of hand tools, knives, etc. The meat must be removed and/or stored in clean containers, which solely are used for meat. Disposable containers will assure hygienic transport and storage, but will be costly.

2.7.6 Packaging

The meat may be packaged ready for the retail trade. If this is done, the packaging must be done in a way to prevent contamination of the meat. The packaging material must be clean and approved for food.

2.7.7 Freezing/delivery

If the meat is frozen the freezing capacity must be sufficient to assure correct freezing.

2.7.8 Condemned products

A separate lockable room or area for keeping condemned material until the end of the working day should be provided. An incinerator or a deep pit should be available for disposal of condemned material.

2.7.9 Liquid and solid waste disposal

The easiest disposal method is to divert effluents into existing pools, rivers or lakes. However, this method cannot be recommended in view of the consequent contamination of water sources for humans, and domestic and wild animals.

For the safe disposal of liquid and solid waste, the following action should be taken:

- 1. Separation of blood**
 - 2. Screening of solids**
 - 3. Trapping of grease**
- 1. The blood from slaughtered animals will coagulate into a solid mass, which may block up both open and closed drains. It is therefore recommended that the blood is collected and used for human consumption, stockfeed production or fertilizers, if the religious and cultural traditions allow the use of blood.**
 - 2. Solids (meat or skin trimmings, hair, pieces of bones, hooves, etc.) must be screened. This may be done by providing the drains with vertical sieves.**

- 3. Effluents from slaughterhouses always contain small amounts of fat (melted fat or small pieces of fatty tissues). Grease traps should be installed in the drains. The fat solidifies, rises to the surface and can be removed regularly.**

The final effluent disposal will depend on local conditions and legislation. Disposal of the effluents into a lake or permanent river should not be allowed because it will contaminate the stream.

For further details see FAO (1978), Mann (1984), and the Danish Academy of Technical Sciences (1985).

2.8 Environmental hygiene

Environmental hygiene and its implementation will depend on the area where the slaughterhouse/meat plant is situated. The precautions to be taken will be different if the site is in a town or

in the country.

The main principles of environmental hygiene will consist of:

- **proper fencing (public, dogs, etc.)**
- **pest control (rodents, insects)**
- **liquid and solid waste disposal**

2.8.1 Proper fencing

To prevent access of unauthorized persons, the public, dogs and other animals fencing must be erected around the slaughterhouse area. The fencing should have contact with the ground at the lower edge and should be high enough to prevent access to the grounds.

2.8.2 Pest control

Pests (insect, rodents and birds) should be controlled to prevent their access to slaughterhouses, production areas and storage departments. This is best achieved by the construction of buildings and working places where access of insects, rodents and birds is hindered, but it will be almost impossible to secure buildings totally against pests. However good design and construction may delay the entry of pests which is a worthwhile objective of an overall rodent control programme. Even if the buildings are well-constructed and as pest-proof as possible it will be necessary to have a regular pest control.

2.8.3 Insect control

Principles in insect control may be:

- 1. Biological control through emphasis on the natural enemies of pests.**

- 2. Cultural control through alteration of the environment to make it unfavourable to pests. Sanitation programmes and water management are examples.**
- 3. Physical and mechanical control. Burning and sticky adhesives are examples.**
- 4. Autocidal control, disrupting the breeding cycle of a pest (release of sterilized male insects or genetically altered insects).**
- 5. Behavioural control, which involves the identification, production, and application of chemical attractants which draw the insects to a trap or interrupt and confuse breeding patterns.**
- 6. Chemical control, which is the most obvious control method, but also the most controversial of all control methods. This**

method includes chemical insecticides but non-chemical methods should be employed if possible.

These principles can also be used for the control of rodents and birds but the slower generation time of these animals reduces some of the above-mentioned alternatives.

2.8.4 Rodent control

The most effective way to control rats is to separate them from food supplies forcing the rats to migrate in search of food thus depressing the reproduction rate. This can only be done through careful management of hygiene standards in food production.

Other principles in rodent control are:

- **bulical control**
- **bulical control**
- **bulogical control**

Chemical control

The most used method for chemical control of rodents is to prebait which overcomes most problems of shyness and avoidance when baiting. In prebaiting a non-poisoned bait is introduced for a rat population over a period and then the non-poisoned bait is replaced with the identical poisonous variety of bait.

The rodenticides used as baits can be divided into two main types, multiple dose of chronic chemicals, and single-dose (acute) rodenticides. According to the situation, each type can be recommended.

The type of bait station used will depend on its location. It is important to prevent spread of rodenticides in the production areas and the bait stations must be inspected regularly.

Chemical control may include the use of rodenticides as tracking powder. These materials kill rats when the animal grooms itself after having been in touch with the powder. Tracking powders (like other baits) should not be used in production areas.

Physical control

The best known method of physical control is traps. Trapping is of special importance in an environment where food is produced, handled or stored because poisonous baits cannot be used for safety reasons.

Biological control

Rodents (rats) have natural enemies such as cats and dogs, but these animals should not be permitted to control (kill) rodents in food production areas.

2.8.5 Bird control

The best control is to prevent the birds from having access to buildings. It is important to understand the relationship between birds and their environment. Bird attractants may be food supplies, water, special vegetation around buildings, etc. and these attractants must be removed or modified.

Toxicants, shooting and trapping may be used to control birds.

2.9 Liquid and solid waste disposal

Handling of liquid and solid waste influences both hygiene in processing and of the environment (see 2.7.9), the latter depending on the precautions taken to avoid contamination with liquid and solid waste.

2.10 Personal hygiene

Personal hygiene will usually be the main element in the term “hygiene”; the reason being obvious. Bacteria causing diseases

or spoilage may be carried and transmitted to surfaces and food by workers handling the food products.

2.10.1 Hand-washing

Careful and frequent hand-washing will do much to reduce contamination. Therefore hand-washing facilities must be sufficient if the water supply is adequate.

Basically there should be two sites where the staff can wash their hands - the rest room and the working area where sufficient handwashing facilities must be placed close to the working places. If the hand-washing facilities are situated in particular areas away from working places, there is a great risk that they will not be used.

It must be impressed on the staff that hand-washing must be done:

- **before work starts**
- **after using the toilets**
- **after touching dirty objects and materials**
- **after smoking and eating**

It must be impressed on the staff that hands will be contaminated if used for scratching the skin or the hair, correcting clothes and picking the nose. Bacteria may be transmitted to the hands by these acts and thereafter transmitted to meat (food) which is handled by hand.

Special guidelines concerning hand-washing must be followed. The management of slaughterhouse/slaughter facilities or the authorities may require the use of a special bacteriostatic soap or dipping of the hands after washing in a germicidal rinse etc. Use of a nail brush is recommended because bacteria often hide

along and under the nails.

2.10.2 Working clothes

The clothing of slaughterhouse workers must be clean. The purpose is not to protect the worker against contamination but to protect the meat/food against contamination. Working clothes must be used exclusively in the working area and nowhere else. If possible, it is advisable to avoid admittance from the unclean area to the clean area without changing clothes. Working routines should be planned in a way that the staff works either in the clean area or in the unclean area. The staff may eventually be allowed to go from clean to unclean work but never in the opposite direction, except when they have changed working clothes and washed hands.

Working clothes should be comfortable and easy to wash. Their design should encourage good hygiene habits. Light coloured

working clothes show the need for cleaning earlier than dark coloured working clothes.

In tropical climates a loincloth is recommended dispensing with working clothes.

In areas where more clothes than loincloths are necessary, aprons made of washable or even waterproof materials, such as rubber, are recommended.

Working clothes should be free of loose adornments (buttons, sequins etc.). During work jewellery, wrist-watches etc. are prohibited as these objects may be sources for contamination and make hand-washing difficult.

Working clothes should ideally be supplied by the slaughterhouse and a laundry service is recommended to assure a certain level of hygiene.

Arrangements for storage of aprons and tools should be available outside toilets and rest rooms.

2.10.3 Hair covering

Human hair and beards are normally heavily contaminated with bacteria and to prevent contamination of food a hair or beard covering in the process area is a necessary part of the working clothes.

Many different types of hair coverings are seen in the food industry. It is important that the hair is completely covered and that the covering is clean. Disposable or washable hair and beard coverings are recommended.

2.10.4 Gloves

If the use of gloves is indicated they must be kept in the same good hygienic conditions as hands, otherwise it is better to avoid

their use. Gloves may be of rubber or plastic and they are used to protect the meat against contamination. They may also be used to protect the hands against knife cuts and will then be made of steel. Great care should be taken to keep a certain hygienic standard of these gloves.

2.10.5 Health

Good health is important for workers in the meat industry. Ill persons will often be carriers of more microorganisms (pathogenic microorganisms) than is usually the case. These microorganisms may then be transmitted to the meat/food with the risk of causing disease to the consumers. Illness must always be reported to the manager and/or the meat inspector of the slaughterhouse who will decide if the worker can stay or has to leave.

2.11 Cleaning/disinfection standard

The cleaning programme (see 7) must be performed regularly, dependent on the demand for cleaning in the specific areas. The requirements for cleaning have to be defined before establishing cleaning programmes (see 7.4).

The disinfection programme should follow the cleaning programme and must be planned in relation to the previous cleaning programme and specific requirements.

Sanitation includes more than disinfection, and procedures concerning sanitation (pest control, waste disposal, maintenance of buildings, proper fencing, etc.) should be planned and carried out accordingly.

2.12 Hygiene standard

It must be impressed on everybody employed in the meat/food industry, that hygiene concerns both:

- **process hygiene**
- **environmental hygiene**
- **personal hygiene**
- **cleaning, disinfection/sanitation**

and that regulations in this regard must be observed.



3. MATERIALS USED IN SLAUGHTERHOUSES AND MEAT PROCESSING PLANTS INCLUDING EQUIPMENT

Materials used in slaughterhouses and meat processing plants depend on the construction and size of buildings. Furthermore, the choice of materials will depend on possibilities of supplies and these possibilities will depend on geographical conditions, cultural traditions and expenditures on materials.

As far as possible local construction materials should be used. These may be quarry stone or lava blocks, concrete, limestone or asphaltstabilized bricks. Nevertheless concrete is recommended for floors. Materials should be chosen to facilitate cleaning.

Wood will often be available and will be used for different kinds of equipment but it has a certain disadvantage as regards hygiene. When wood is used for cutting boards and chopping blocks or other working surfaces, deep splits appear which will be difficult to clean especially because wood swells when moistened. When possible a better hygienic standard may result

if wood is replaced by plastic, but only if the maintenance standard of the plastic is satisfactory. Cutting boards and chopping blocks must be planned regularly or when needed. Cutting boards should be preferred.

3.1 Types of surfaces

Different materials will have to be used for different kinds of equipment but often metal will be used. The type will depend on the equipment and should be resistant to detergents and disinfectants generally in use.

3.1.1 Stainless steel

Stainless steel will corrode when exposed to strong alkalis, acids and chlorine.

3.1.2 Aluminium, zinc, lead, copper and tin

Slightly alkaline detergents containing sodium metasilicate are recommended to minimize the corrosive effect. When these metals are exposed to chlorine, there will be some corrosion.

3.1.3 Rubber

Rubber surfaces may be damaged when exposed to acidic detergents or detergents containing organic solvents.

3.1.4 Plastic

Plastic will deteriorate when exposed to organic solvents.

3.1.5 Concrete and cement

Alkaline detergents containing metasilicate are recommended. When exposed to acidic detergents, concrete and cement will deteriorate.

3.1.6 Glass

Glass will frost over when exposed to alkaline detergents.

3.1.7 Painted surfaces

Strong alkaline detergents will deteriorate painted surfaces.

3.1.8 Galvanized iron

Galvanized iron will corrode when exposed to alkaline detergents as well as acidic detergents.

3.1.9 Wood

Wood is difficult to clean because of splits, which are nearly impossible to clean totally. Chlorine is therefore recommended for disinfection because it has a good germicidal effect and also decomposes different types of organic matter.



4. PRINCIPLES OF CLEANING

4.1 Types of soil

Before planning a cleaning programme one of the essentials is to know which types of soil are present in the area to be cleaned. Fat and protein are the most common types of soil in the meat industry. Characteristics of soil types are shown in Table 1.

Table 1

Soil characteristics

Component on surface	Solubility characteristics	Ease of removal and changes induced by heating soiled surfaces
Carbohydrate &ldquosugars&rdquo	Water soluble	Easy to remove, but more difficult to clean when caramelized
Fat	Water insoluble Alkali soluble	Difficult to remove
Protein * <u> </u>	Water insoluble Alkali soluble Slight acid soluble	Very difficult to remove and even more difficult when denaturated
Salts	Water soluble Acid soluble	Some salts are easy and some difficult to remove. If

Monovalent		interaction occurs with other constituents these substances will be more difficult to remove
Polyvalent	Water insoluble Acid soluble	

* See Table 2

4.1.1 Carbohydrates

Carbohydrates are not a usual type of soil in slaughterhouses, but may occur in meat processing plants (sausage production). Normally carbohydrates are easily removed with water. Detergents may increase the cleaning effects.

4.1.2 Fat

Fat can be removed to give an optically clean surface using water at a temperature of more than 50°C for pork fat and more than 55°C for beef fat. The efficiency can be improved by adding a detergent.

4.1.3 Protein

Removal of protein depends on the treatment the proteinaceous soil has been exposed to before the cleaning procedure. Protein will coagulate and be difficult to remove when exposed to hot water (more than 60°C) for a long time. A short exposure to hot water may not cause coagulation of protein. The surfaces soiled with protein should be kept wet until the cleaning procedure can start.

Table 2. Characteristics of proteinaceous soil types

Type of soil	Cleaning technique	Cleanliness achieved
Protein		
not dried on surface	Remove with water (manually or mechanically)	Sensorily clean
dried on surface	Soften with water and detergent and remove with mechanical force (pressure, manually)	Adhesive layer often left behind
dried on and/or	Soften with water and detergent	Crusts, coatings
burnt in surface	and remove with mechanical force (pressure, manually)	and adhesive layer often left behind

4.1.4 Mixed types of soil

Often the soil type is a mixture of protein and fat. The fat may be removed when using hot water, but hot water may coagulate the protein. The water temperature must therefore not exceed 60°C. A reasonably good effect will be obtained using a detergent and water with a temperature between 45–55°C or even cold water with a suitable detergent. If cold water is used, the dosage of detergent must be larger for most detergents than when used with hot water.

Besides protein and fat, smears are often blended with mineral salts from water, especially calcium and magnesium and to a lesser extent iron.

Mineral salts are best removed with acids or acidic detergents. The acidic detergents have a reduced cleaning effect and have a corrosive effect against some types of surfaces. They must therefore be used carefully with regular frequency when the water has a large content of mineral salts.

Another type of smear may be described as “a waxy mass”. This kind of smear consists of an undefined mixture of fat, protein, mineral salts and residues of detergents. This type of smear will often be found where the cleaning procedure has been irregular, for example wrong working routines, wrong dosage of detergents or wrong detergents. This waxy mass will not be alkali or acid-soluble. The only way to remove this smear type is by using mechanical force. Often scrubbing by hand and scrubbing brushes or scrubbing tools (nylon pads etc.) will be the only way to remove this kind of deposit.

It is important to be aware of the difference between deposits of mineral salts and those of a waxy mass.

4.2 Detergents

Any substance which, either alone or in a mixture, substitutes physicochemical energy for some of the mechanical energy

required for removing dirt can be classified as a detergent. Detergents influence the amount of energy or work that must be applied to a cleaning system.

Increasing one kind of energy can compensate for shortage of other kinds of energy. For example manual power will often be used as compensation for shortage of detergents or hot water.

Water alone is not a very efficient cleaning agent because of its high surface tension. Adding of detergent to water facilitates the contact between water and surface soil because detergents enable water to penetrate soil by lowering the surface tension. If water is used as the sole cleaning agent a considerable amount of mechanical energy is required.

A good detergent should have the following properties. It should be:

- 1. able to soften water completely**
- 2. completely soluble in water**
- 3. non-corrosive to surfaces (metals and buildings)**
- 4. non-toxic and biodegradable**
- 5. economical in use**

It should have:

- 6. good wetting or penetrating ability**
- 7. emulsifying ability on fat**
- 8. dissolving ability on food solids**
- 9. deflocculating, dispersing or suspending ability**

10. good rinsing properties

11. scale and rust removing properties

No detergent or cleaning compound can be called an all-purpose detergent. None of the alkalis, acids or surface-active agents fulfil the requirements of a good detergent when used alone.

Certain mixtures of these chemicals will combine several properties in one product which will be effective for a particular cleaning operation.

The types of chemical compounds used to achieve the functions of cleaning described above are:

- 1. Alkalis and alkaline salts**
- 2. Surface active agents**

3. Sequestering agents

4. Inhibitors (anti-corrosive agents)

5. Acids

6. Fillers

4.2.1 Alkalis and alkaline salts

Sodium hydroxide (caustic soda) is a common ingredient in detergents for the food industry. It is a powerful detergent and is used to suspend protein and to convert fats to soap, and it is cheap. However it corrodes aluminium and galvanized iron, strips paints, and presents a hazard to personnel using it. It is available in most geographical areas.

Sodium carbonate (soda ash) is not as efficient a cleaning agent as sodium hydroxide, but it is a cheap source of alkalinity and is

used as a detergent filler. It is corrosive to aluminium and galvanized iron, and forms a scale of calcium carbonate and other insoluble salts in hard water. It is available in all geographical areas.

Sodium metasilicate is an effective detergent for many purposes. It is an excellent emulsifying and suspending agent and has reasonable wetting and rinsing properties. It possesses anticorrosive properties but will deposit on stainless steel. It may also deposit with soil as a grey-white coating if used in water above 70°C.

4.2.2 Surface active agent

This kind of agent is employed in a variety of cleaning applications such as wetting, emulsifying and penetrating agents. The main function is to lower the surface tension.

Anionic surface active agents dissociate in solution to give a negatively charged surface active ion and a small inactive action. Most commercial surface active detergents belong to this group. Several agents of this type are available but the alkyl aryl sulphonates are the most common surface active agents.

Nonionic surface active agents do not yield ions in aqueous solutions and are compatible with either cationic or anionic materials. Mixtures of anionic and nonionic surface active agents in a ration of 2:1 in detergent formulations appear to be suitable for the food industry. It is not common to use nonionic surface active agents alone because they are more expensive than anionic surface active agents.

Cationic surface active agents dissociate in a solution to yield a positively charged surface active ion and a small inactive anion.

Their performance as detergents is only fair but they exhibit anti-

microbial activity and can be used as disinfectants or in mixed detergent-disinfecting agent mixtures.

4.2.3 Sequestering agents

Sequestering agents are used to bind calcium and magnesium and prevent the formation of insoluble calcium and magnesium salts by the interaction of hard water or dirt with the detergent. The amount of sequestering agents needed depends on the hardness of the water, the composition of the detergent and the composition of the soil.

Different chemicals have the ability to be effective as sequestering agents. Common in use are EDTA (ethylenediaminetetraacetate), NTA (nitrilotriacetic acid) and different phosphates.

Sodium tripolyphosphate, sodium tetraphosphate and sodium

hexametaphosphate are phosphates mainly used in detergent formulations. In addition to removing the minerals causing water hardness, they have varying functions in emulsification, protein peptization and dispersion.

4.2.4 Inhibitors

Inhibitors neutralize the corrosive effect of some chemicals. The use of inhibitors is dependent on the composition of the detergent and the materials which will be cleaned.

Silicates may be used as anti-corrosive agents in alkaline detergents but will deposit on stainless steel and it is therefore important to know on which materials they will be used.

4.2.5 Acids

Acids are used to remove mineral deposits but they have reduced cleaning effects and are corrosive to different materials

(especially galvanized iron and aluminium). The inorganic acids are principally more corrosive than the organic acids.

Acidic detergents are mixtures of one or more acids and surface active agents, and may be inhibitors too. These detergents have a reasonable cleaning effect. If the mineral deposits are removed by acids alone, the cleaning effect will be minimal and it may be necessary to remove fat and protein with an alkaline detergent before removing the deposits with acid.

The inorganic acids used are phosphoric acid, nitric acid, sulphuric acid and hydrochloric acid.

The organic acids used are gluconic acid, tartaric acid, citric acid, acetic acid and sulphamic acid.

4.2.6 Fillers

The purpose of fillers is to make detergents fluid or to turn

fluidized detergents into powders. As fillers sodium chloride or sodium sulphate may be used. The last mentioned is cheap and has some cleaning effect, especially when mixed with chemicals with a better cleaning effect.

4.3 Examples of formulas for detergents

4.3.1 Alkaline detergents

A. Strong alkaline detergent

69% Sodium carbonate

25% Sodium hydroxide

6% Nonylphenol (surface active agent)

B. Alkaline detergent

59% Sodium carbonate

35% Sodium triphosphate

6% Nonylphenol (surface active agent)

C. Alkaline detergent

37% Sodium carbonate

37% Sodium metasilicate (anti-corrosive effect when used on aluminium and galvanized iron) 20% Sodium tripolyphosphate

6% Nonylphenol (surface active agent)

4.3.2 Acidic detergents

D. Strong acidic detergent

Phosphoric acid (50%)

Sulphuric acid

Thio-urea (anticorrosive agent)

Nonylphenol (surface active agent)

E. E. Acidic detergent

Sulphamic acid

Sodium sulphate

Thio-urea (anticorrosive agent)

Nonylphenol (surface active agent)

4.4 Choice of detergent

The type of metal and building materials (including paint) used in the area to be cleaned severely limits the choice of detergent.

Aluminium and galvanized iron, which are frequently used, corrode rapidly in strongly alkaline or acid detergents. Although detergents can be formulated so that they do not corrode these metals, their effectiveness as cleaning agents is usually reduced.

Where it is suitable to clean by hand only mild detergents should be used. Automatic cleaning techniques enable the use of

stronger detergents.

Depending on the actual conditions (i.e. detergent supply, economics, etc.) it is recommended to use a single cleaning chemical (e.g. sodium carbonate) if the alternative is no cleaning agent. In most instances the choice of a suitable detergent must be a compromise between the efficiency of the detergent, the need to protect metals, building materials and personnel, the cleaning methods, the frequency of cleaning and economics.

The cost of the detergent is not a guide to its efficiency. Only actual tests with a particular detergent during a specific cleaning operation will give some indication of its efficiency.





5. PRINCIPLES OF DISINFECTION

The main objective of a cleaning programme is to control microbial activity. Although an adequate cleaning programme will eliminate nearly all the soil present, it will not destroy or remove all the microorganisms. This requires a second step - disinfection.

Disinfection is defined as: “the destruction of microorganisms but not usually bacterial spores; this does not necessarily involve killing all microorganisms, but reducing their number to a level not normally harmful to health. The term is applicable in a commercial context solely to the treatment of inanimate objects and materials”. This definition assumes that where total numbers of surviving microorganisms are small, undesirable types such

as pathogens are less likely to be present in significant numbers.

Disinfection methods can be divided into two groups:

- 1. Non-chemical disinfection methods**
- 2. Chemical disinfection methods**

5.1 Non-chemical disinfection methods

5.1.1 Heat/steam

In many cases steam is very good for disinfection but it may be inconvenient or impractical due to the following reasons.

Providing steam is expensive and may cause materials to deteriorate and equipment to distort. If steam is used it will take considerable time to heat and cool equipment. It may cause baking-on of food and other residues. Visibility is reduced in the

environment thus reducing the effectiveness of the sanitizing procedures. Finally it gives condensation problems.

Insufficient heating may result in the incubation of microorganisms in inaccessible parts of the machines and the equipment.

5.2 Chemical disinfection methods

The most essential for an effective chemical disinfection programme is a clean surface. Consequently, to achieve microbial control the cleaning and disinfection programme must be thorough, compatible and totally effective.

Note: A disinfectant will not cover up faulty cleaning practices

The choice of chemical disinfectants is determined by the following considerations:

- **Public health regulations**
- **Spectrum of effectiveness, i.e. ability to kill many types of microorganisms**
- **Must be efficient under the conditions of use**
- **Quick action**
- **Presence or absence of organic matter**
- **Corrosive properties**
- **Type of processing area and type of surface to be disinfected**
- **Non-toxic and gentle to the skin**
- **Inexpensive**

- **Must not affect the odour or flavour of the food processed on the equipment disinfected**
- **Must be easily rinsed away and leave no toxic residues**
- **Easy to dispense and to handle**
- **Must be safe in use and must not affect the operators who use it.**

5.3 Disinfectants

Manufacturers offer a large number of disinfectants, each claimed to be the best on the market. Nevertheless the only ones suitable for the food industry contain chemicals of one of the following groups:

- **Chlorine and chlorine-releasing compounds**

- **Quarternary ammonium compounds**
- **Amphoteric (ampholytic) compounds**
- **Phenolic compounds**
- **Peracetic acid**

5.3.1 Chlorine and chlorine-releasing compounds

Chlorine is the most effective disinfectant available and sodium (or calcium) hypochlorite is a cheap disinfectant commonly in use. The hypochlorites have a characteristic smell produced by free hypochlorous acid which is considered to be the germicidally active form of chlorine. A practical disadvantage of sodium hypochlorite is the risk of corrosion to all common metals (especially aluminium and galvanized iron), except perhaps high quality stainless steel.

The disinfectant properties of the hypochlorites depend on a number of factors:

- a) the concentration of available chlorine, which should be 200–300 mg/l
- b) pH of the solution (to reduce the breakdown during storage, the hypochlorite solution should be maintained at pH 9–11)
- c) Temperature
 - a- The hypochlorite is more efficient if the concentration and
 - c) temperature are raised and/or the pH is lowered (8.3)
- d) Contact time
 - c- To decrease the corrosive effect the temperature should not exceed 50–60°C and the contact time should not exceed 30–60
 - d) min.
- e) absence of organic material. Organic material consumes available chlorine and reduces the disinfecting capacity.

When using hypochlorite it is very important to ensure that hypochlorites and acids are never mixed due to development of toxic gases which may cause severe damage to personnel.

5.3.2 Other chlorine-releasing compounds

The organic chlorine disinfectants are chloramines (chloramine T) and chloroisocyanurates.

Chloramine T should only be used where long exposure is practicable as its bactericidal activity is slow compared to hypochlorite. Chloramine T is more stable than hypochlorites not only in solution but also in powder form. It is also less irritating and less corrosive than hypochlorites.

The chloroisocyanurates are unstable both in solution and in the presence of non-ionic surface active agents.

5.3.3 Quarternary ammonium compounds

The cationic synthetic surface active agents or quarternary compounds are excellent disinfectants. The quarternary ammonium compounds are free of odour and colour, are highly stable and have little corrosive action on metals when used in recommended concentrations. They are more effective against gram-positive than gram-negative bacteria. They are more active in the presence of small amounts of organic matter than any other class of disinfectants, but are inactivated by soaps, anionic detergents and inorganic polyphosphates. They are more expensive than hypochlorites.

Utensils and equipment should be thoroughly rinsed after applying these compounds as disinfectants because of possible toxic effects.

5.3.4 Amphoteric (ampholytic) compounds

Amphoteric compounds are essentially alkyl or acyl amino acids.

They combine detergent and disinfectant properties. They are of low toxicity, are non-corrosive and are expensive. They are effective against both gram-positive and gram-negative bacteria.

5.3.5 Phenolic compounds

Phenolic compounds are not generally suitable for use in the food industry. Some halogenated phenol derivatives can be used in the meat industry. They are effective against spores, viruses, moulds and grampositive and gram-negative bacteria. They are corrosive and can irritate the skin of personnel.

5.3.6 Peracetic acid

A quite new disinfectant is a mixture of peracetic acid, hydrogen peroxide and acetic acid, which is stable and is effective against bacteria, spores, yeasts, moulds and viruses. The active agent is peracetic acid. The mixture is non-corrosive.

5.4 Choice of disinfectant

The choice of disinfectants will normally depend on several factors, one often being the supply situation when the more specific disinfectants are marketed by only a single or a few companies. Expenditure on disinfectants will also be important and the cost must be compared to the characteristics of the disinfectant before a choice is made. The previous cleaning programme should also be considered. A disinfectant will never assure a demanded hygienic level without previous cleaning.

The choice will often be hypochlorites which are inexpensive disinfectants with a good germicidal effect. Precautions to prevent corrosion of the surfaces and to prevent development of toxic gases, i.e. to prevent the possibility of mixing hypochlorites and acids, should be taken.

5.5 Emergency disinfection

For emergency disinfection, i.e. when disinfection is required during processing because of animal disease (anthrax, foot and mouth disease etc.) the following disinfectants are recommended:

- a. sodium hydroxide (caustic soda or lye) in a hot solution of approximately 2% for foot and mouth disease and 5% for anthrax.**
- b. (Avoid any splashes in eyes or on skin (caustic). If an accident happens wash clean water).**
- c. sodium hypochlorite solution: 0.5% available chlorine**
- d. hot water (90°C or more) or steam**
- e. Chloride of lime for lairages, stables and transport vehicles: approximately 5% solution.**



6. PRACTICAL PROCEDURES IN CLEANING PROCESSES

6.1 Manual cleaning using brushes and similar equipment

Manual cleaning is adaptable to all types and sizes of buildings, equipment and tools but its effectiveness depends heavily on the worker. Manual cleaning will always require considerable input of manpower. Nevertheless, it may be the cheapest method.

When cleaning manually great care must be taken to assure that brushes and equipment are cleaned to avoid cross-contamination. Essential will be frequent changes of water and water/detergent solutions. It is recommended that smaller

equipment and items are collected for central cleaning by hand and in this respect the following 3-tank system can be recommended:

- 1. Remove soil from the equipment by scraping the surfaces (see Fig. 4 a).**
- 2. Transfer the equipment to tank no. 1 which contains a suitable solution of water and detergent. Loosening the soil may require soaking for a period (see Fig. 4 b).**
- 3. The equipment is then transferred from tank no. 1 to tank no. 2, which contains a solution of water and detergent. The equipment is scrubbed clean (see Fig. 4c).**
- 4. The equipment is rinsed in water (from pails or running water from water hoses) (see Fig. 4 d).**
- 5. The next step is transferring the equipment to tank no. 3**

containing hot water (77°C) for at least one-half minute to have a disinfecting effect (see Fig. 4 e).

The equipment is stacked to drain and dry quickly.

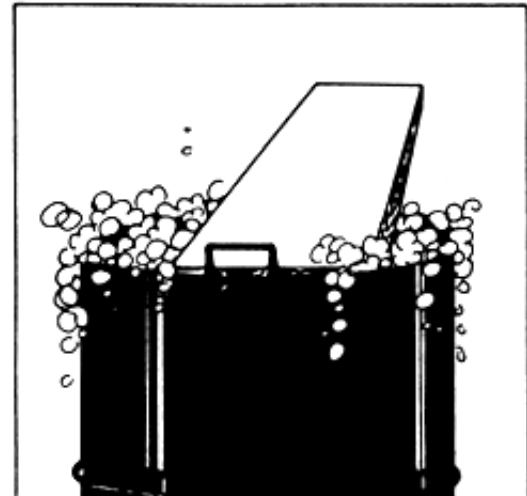
An alternative to step 5 is to use a solution of chemical disinfectant and allow contact for several minutes. Post-rinsing in clean water is required after chemical disinfection. For chemical disinfection a solution containing 200 ppm of available chlorine may be recommended. If the equipment is made of wood, the solution should contain 500 – 1000 ppm of available chlorine.

If the water supplies are insufficient, step 2 may be omitted. Thorough removal of soil from surfaces will then be required.

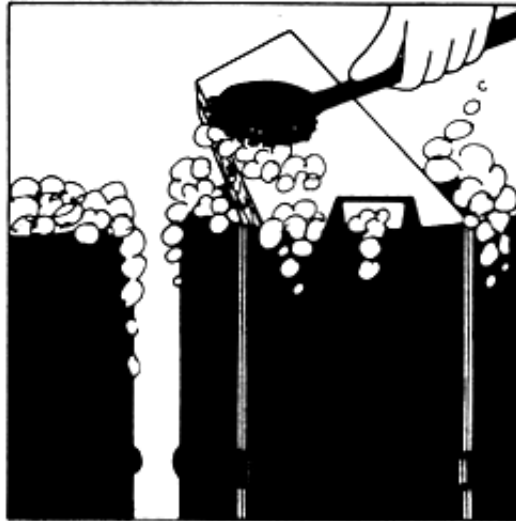
If manual cleaning with brushes is used for cleaning large freestanding equipment and buildings the water has to be

brought to the parts. The best solution will be to use running water from water hoses. Where water supplies do not allow running water a 3-pail system is recommended for cleaning. Two pails should contain a solution of water and detergent and the third clean water. The pails and brushes etc. should be placed in a trolley.

Fig. 4. Manual cleaning, 3-tank system. (Illustration by U. Boyter).



a) Removing of soil

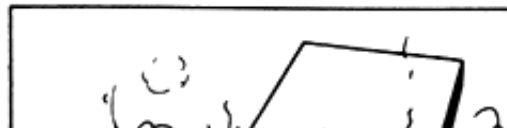


b) Loosening of soil



c) Scrubbing with water/detergent and manpower

d) Rinsing with clean water





a) Disinfection

- 1. The first pail containing water and detergent is used for dipping and cleaning of the brushes.**
- 2. The water/detergent solution in the second pail is used for cleaning. A measuring cup or a small container may be used for application of the water/detergent solution to the surfaces. The surfaces will then be cleaned by a clean water/detergent solution.**

3. The clean water in the third pail is used for rinsing purposes.

If the rinsing can be done with running water it should be preferred. Then the three-pail system will be reduced to a two-pail system.

6.2 Mechanical cleaning

It will be obvious that energy is required for cleaning purposes. The mechanical force needed will be supplied as electrical force or pressure, or maybe a combination of both (e.g. pressure cleaners).

Electricity may be used for automatic floor scrubbing machines or vacuum cleaners for water suction in food processing areas. These machines will not be economical in use in processing areas, but will have advantages in areas with different functions such as resting rooms, walking areas etc.

Pressure will be used in manual spraying systems. These systems may be constructed with special nozzle arrangements or with a handoperated pump and special nozzles to give a certain pressure. The nozzles are supplied with different sizes of holes and different spreading angles (see Fig. 5). When worn, nozzles should be replaced. As a manual spraying system, sprays constructed for spraying trees or flowers with insecticides etc. can be recommended.

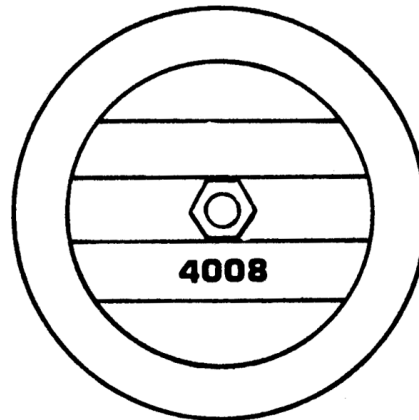
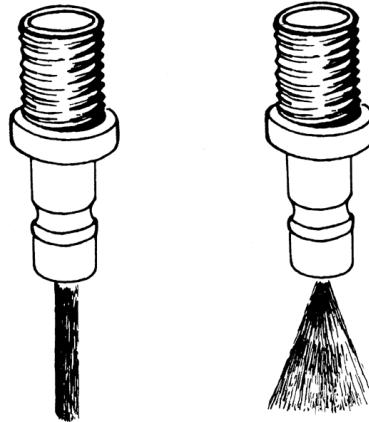


Fig. 5. Principle in nozzles. The first two figures show the spreading angle and the last two figures show the size of hole(mm).

The spreading angle is important for pressure against surfaces. An angle of 0° gives a massive jet of water. If the angle is larger, the jet of water will be less massive (see Fig. 6).

Fig. 6. Nozzles with spreading angles of 0° and 45° . The jet of water from the 45° angle is obviously less massive than the jet of water from the 0° angle.



The nozzle principle will be the same independent of manual or automated systems.

6.2.1 Pressure cleaners

There are different types of pressure cleaners available and the choice will always be a compromise between various advantages and disadvantages.

Pressure cleaners exist in many varieties and trade marks and for specific details it will be necessary to obtain information from manufacturers, instruction handbooks, etc.

Electric installations and water taps will be necessary. Application of detergent may require the installation of compressed air (air compressors).

Pressure cleaners may give pressures from 4–180 bar and it will be possible to change the pressure between these values according to cleaning purposes.

The pressure cleaner systems will either be:

- **high pressure-low volume system or**
- **low pressure-high volume system**

High pressure-low volume systems are economic in use

concerning water consumption but have several disadvantages concerning the maintenance of buildings, machines and equipment. When using high pressure for prerinsing and rinsing, the pressure may cause spreading of soil in the whole area, even under the roof construction.

Rinsing with high pressure will cause aerosols. Aerosols are small droplets of water that may contain chemicals and microorganisms which may lead to irritation of the respiratory tract. High pressure cannot be recommended for application of detergents and disinfectants because of these aerosols. If used for application of chemicals the pressure must not exceed 5 bar. Aerosols may also cause problems when penetrating coverings of electric installations.

High pressure can damage the wall and floor surfaces of the buildings, the equipment and machines. For example, high pressure used wrongly on tiled walls may loosen the tiles.

The advantages of using high pressure are the short time and low water consumption for rinsing purposes and removal of most soil types. It will be very time-consuming if used for prerinsing because of the low water consumption. Water hosing may then be used for prerinsing.

Low pressure-high volume systems are costly in use because of large water consumption.

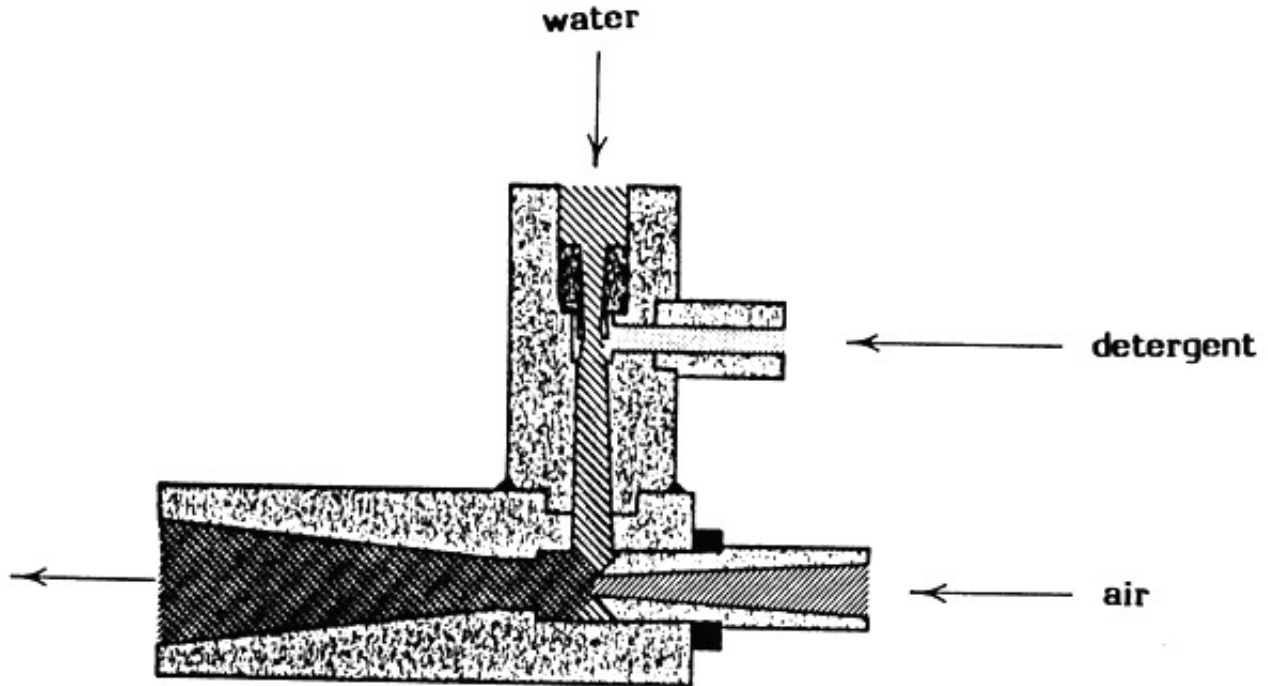
Cleaning systems working with low pressure (30 bar) and low volume (18–20 l/min) have been developed. The low volume is increased a little compared to the high pressure-low volume system but overall this kind of cleaning system may save water because the system can be used for both prerinsing and rinsing.

6.2.2 Application of detergent with the injector-system

When using pressure for cleaning the detergent can be applied

after the same principle independent of the pressure and the volume. Injector systems can be combined with the different pressure systems. The injector will be connected to the water supply of the cleaning system and have an intake for water, detergent and air (see Fig. 7). When used for rinsing purposes the intake of detergent and air can be closed.

Fig. 7. An injector showing intake of water, detergent and air. The intake of detergent and air can be closed.



6.2.3 Working procedures

When using pressure cleaners the cleaning results will depend on :

- **Water pressure and spreading angle**
- **Water amount**
- **Detergent**
- **Water temperature**
- **Time and efficiency**

When choosing pressure cleaning systems, the instructions from the supplier must be followed and personnel given sufficient instructions and practical training before start of cleaning.

Special instructions for using the appropriate nozzles, choosing an appropriate length of jet pipes and correct handling of jet pipes must also be given.

Correct handling of jet pipes covers:

- **appropriate working rate**
- **appropriate distance from the surfaces which are to be cleaned (see Fig. 8)**
- **appropriate angle achieving a chisel-like effect (see Fig. 8)**
- **appropriate working movements (see Fig. 9)**

Fig. 8 The distance between the nozzle and the surface should be 30 cm and the angle between the surface and the jet of water should be approximately 45° (effect of a chisel).

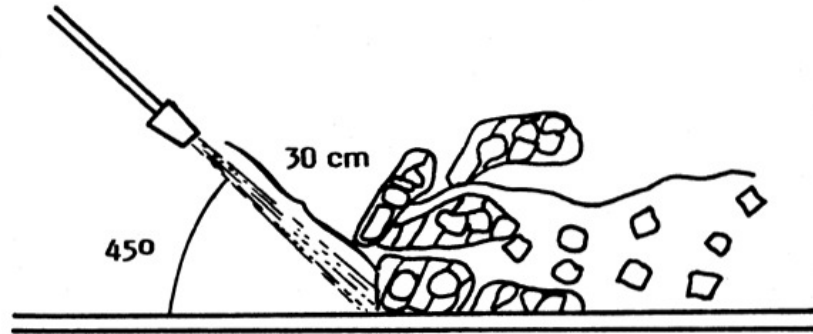
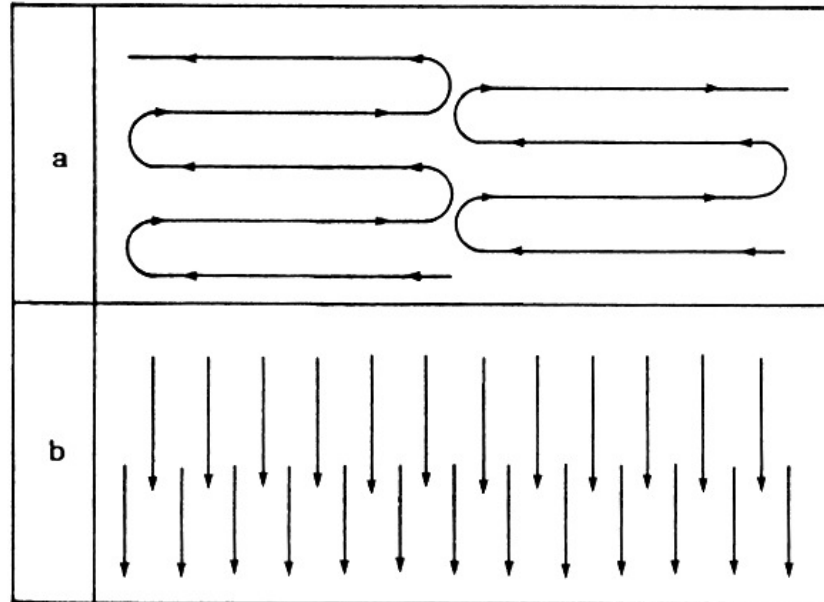


Fig. 9 Jet movements on hard, smooth surfaces



- **Movements for application of detergents. The movements should be smooth and cover an appropriate working breadth. The movements should go from below working upwards.**
- **Movements for rinsing. These should go up and down**

utilizing the water as much as possible.

Conclusion

The systems for cleaning should be chosen in accordance with the actual conditions of the slaughterhouse. If automatic systems are chosen, delivery time of spare parts for the system should be considered as well as the possibility for service when repairs are required.



7. CLEANING PROGRAMME

It is advisable to study in theory a detailed ideal cleaning programme so as to establish a general overview of a cleaning programme.

7.1 The ideal cleaning programme

The programme can be divided into the following subroutines:

- **Clearance for cleaning**
- **Assembling for cleaning**
- **Removal of solid waste**
- **Prerinsing with water**
- **Application of detergent**
- **Rinsing**

- **Disinfection**
- **Post rinsing**
- **Post treatment**
- **Disassembling after cleaning**

7.1.1 Clearance for cleaning

This could be a subroutine of the cleaning programme or a subroutine in processing (see process hygiene) and it will be necessary to establish which one it is. If the carcasses and/or meat have not been removed from the processing area as a part of processing, the first part of the clearance must be removal of carcasses/meat for storage.

It is recommended that each person in processing be responsible for clearing the area concerned as this tends to intensify

discipline regarding tidiness and hygiene. However, one person must have the main responsibility for clearing.

The purpose of clearance after work is to prepare an easy and quick cleaning procedure.

Clearance implies removal of all items which may retard performance. Items which may be damaged by water should be removed. Nonremovable equipment should be covered to protect against water. Water and electric installations may constitute a safety hazard.

Examples of items which should be removed are:

- **packaging materials (cardboard, paper, etc.)**
- **items kept by personnel of the area (personal items)**
- **small or mobile equipment (may be removed for central**

cleaning (see 6.1).

7.1.2 Assembling for cleaning

Assembling for cleaning may be a time-consuming subroutine but it is necessary.

Assembling for cleaning consists of preparing solutions of detergents and disinfectants and maintenance and/or preparation of cleaning materials and equipment (pressure cleaners, hoses, etc.). If there is sufficient running water this will not be a problem, but where running water supplies are insufficient, it may be necessary to provide sufficient water in tanks, pails, drums etc.

If there is sufficient running water it is recommended that water taps be placed conveniently for cleaning. If pressure cleaners are used assembling for cleaning will include controlling if there is oil

in the pump etc. (ref. instructions concerning the pressure cleaners in question).

The maintenance of couplings, pumps, electrical fittings etc. must be done as a subroutine of assembling for cleaning and according to instructions given by the suppliers of this equipment.

Assembling for cleaning will always depend on local conditions and may be time-consuming but cannot be neglected if the cleaning procedure which follows is to be optimal.

7.1.3 Removal of solid waste

Where there are large amounts of solid waste, it should be removed before water is used in the area. It may not be necessary to remove the solid waste in all places in a slaughterhouse, but it is recommended where the amount of

solid waste is large and the water supply is insufficient.

Waste can be collected by a broom or a squeegee and then shoveled into waste containers. Depending on the type of soil the use of a broom will often be the most economical in time.

7.1.4 Prerinsing

The purpose of prerinsing is:

- **to prevent drying of the soil on the surfaces and to moisten the soil and the surfaces**
- **to loosen and collect a small amount of solid waste.**

Prerinsing can be carried out with water supplied from a water hose (water tap) or from a low pressure cleaner.

Water temperature should be adjusted to the remaining cleaning

programme and the types of soil on the specific areas. Hot water can only be recommended for prerinsing where the dirt types mainly consist of fat (see 4.1.2). Cold water for prerinsing will be sufficient on most surfaces if the remaining cleaning programme is optimal.

If large amounts of solid waste have been collected by prerinsing, it must be removed before application of detergent.

Removal of solid waste and prerinsing

These two subroutines have partly the same purpose - to remove most of the solid waste. A thorough removal of waste will decrease the demand for prerinsing and a thorough prerinsing can increase the effect of a less thorough removal of waste.

7.1.5 Application of detergent

The purpose of applying detergent is to decompose and loosen

the soil from surfaces and prevent the soil already loosened redepositing. This principle will be the same for all detergents but the systems for application of detergents may differ (see 6.2.2).

The choice of detergent depends on:

- **type of soil**
- **hardness of water**
- **type of surfaces**
- **system for application of detergent**
- **remaining cleaning programme (water temperature, mechanical force etc.).**

Application of detergent as foam may be recommended if the rinsing which follows is carried out by a low pressure system.

The low pressure system will add less energy to the cleaning system than high pressure cleaning or manual cleaning. It will therefore be necessary to utilize chemical energy as far as possible.

Warm water will normally be recommended for application of detergents but cold water may be sufficient if the detergents are soluble in cold water. Water anyway reaches the temperature of the environment when applied.

7.1.6 Rinsing

Decomposed and suspended soil and detergent residues should be removed by rinsing with water. Rinsing can be carried out with water under pressure (low or high) or with water and manual force.

The optimal water temperature for rinsing will depend on:

- **which detergent has been used**
- **which types of soil have to be removed**
- **which surfaces have to be cleaned**
- **which amounts of water are available**
- **which cleaning system (manual/pressure systems) is used.**

To prevent deposits of suspended soil warm water is recommended for rinsing. In nearly all cases a temperature of 40°C will be sufficient. However, it is better to have a constant water temperature than very hot water but for special purposes a water temperature above 40°C is recommended. Water temperature should be thermostatically controlled.

If pressure systems are used for rinsing, pressure should not be more than 30 bar. Practical experiments have shown that a

pressure of 30 bar and 20 l water per minute will give sufficient cleaning results, both regarding hygiene and economy.

7.1.7 Disinfection

The purpose of disinfection is destruction of microorganisms by the use of chemical or physical agents or processes. The number of microorganisms should be reduced to a level that will not cause the harmful contamination of food.

Choosing the correct disinfectant and method will depend on:

- **surface materials**
- **type of processing area (heat treated or non-treated products)**
- **remaining cleaning programme (especially the detergent)**

- **disinfection method**

The application of disinfectant has to be carried out by low pressure. Sprays (manual sprays or sprays carried on the back, mobile pressure containers etc.) are recommended for disinfection purposes (see 6.2).

Low pressure and high pressure systems may be uneconomical in use because the consumption of water and disinfectant will be larger than when using the previously mentioned sprays. The amount of disinfectant when using the pressure systems may be unnecessarily large. When using the spray system the intensity of disinfection may differ from area to area, depending on the demand for disinfection.

There may be restrictions through legislation on the use of disinfectants and approval may be necessary.

A disinfectant with a broad spectrum is recommended for most purposes. Disinfectants restricted in effect against microorganisms may be used for specific purposes and hypochlorite and peracetic acid can be used for all purposes. Quarternary ammonium compounds and amphoteric compounds may be used on areas where heat treated products are produced.

7.1.8 Post rinsing

To avoid residues of disinfectants on surfaces and to counteract corrosion post rinsing after the disinfection procedure may be required. Post rinsing should be carried out using water from a water hose or from a low pressure system.

It is important to assure that surfaces will not be recontaminated by post rinsing, i.e. water must be of potable quality.

7.1.9 Post treatment

It may be necessary to apply oil (edible oil) on surfaces such as cast iron to avoid the corrosive effect of detergents and disinfectants.

7.1.10 Disassembling after cleaning

Disassembling after cleaning will depend on the equipment and methods used for cleaning, but will always include clearing and cleaning of the equipment used for the cleaning process.

Equipment should be maintained in accordance with instructions from the suppliers and the management of the slaughterhouse.

Cleaning equipment should be stored in a separate room where detergents and disinfectants may also be stored.

Emptying of waste containers and cleaning of these is a part of disassembling as well as switching off the light and closing the doors.

7.2 The whole cleaning programme

The cleaning programme consists of several subroutines which must be considered as one process. None of the subroutines may be changed without evaluating if the other subroutines should be changed at the same time.

When a cleaning programme has been planned concerning use of detergents, methods and equipment, the working programme has to be planned in detail. How it will be planned may depend on local conditions but it is important to ensure that:

- the staff is aware of individual responsibilities for each area**
- the staff knows who has the responsibility when irregularities occur**
- everybody works according to the principle: from clean to unclean**

- **the working routines are planned in such a way that clean and unclean procedures are never mixed**

As an example it may be mentioned that spraying from unclean areas to clean areas should be avoided.

The management should plan working routines for optimal economy and hygiene.

According to actual conditions a single or more subroutines may be omitted but if this is done the required hygienic level must be assured. A few examples are mentioned in 7.4

7.3 Frequency of cleaning

The management of the meat plant has to plan how often the cleaning programme must be carried out. A thorough cleaning programme has to be carried out at least once a day and eventually a reduced cleaning programme could be carried out

before the type of process is changed during the day.

Cleaning requirements may be reduced if the discipline concerning cleaning during processing is at a high level.

The best hygiene standard will be reached:

- **if the processing is planned in a way which ensures minimal contamination of animals, meat, surfaces and personnel**
- **if the discipline concerning clearing and hygiene during processing is good**
- **if the cleaning programme is well planned and well done.**

7.4 Examples of a cleaning programme

The cleaning programme will be set up according to local conditions and a few examples are given below.

Example no. 1

Conditions: Open slaughterplace in a dry and sunny climate.

Restricted or no water supplies are available. The surfaces (floors, tables etc.) must be scraped clean for all waste and soil (see Fig. 10).

Fig. 10. Open slaughterhouse. (Photo by S. Gade Christensen)



If no water supplies are available, the surfaces, knives and hand

tools will be sundried.

If water supplies are available but restricted, water must be reserved for cleaning of knives and hand tools and for hand washing. The surfaces will be scraped and sundried.

If water supplies are available in amounts allowing rinsing of surfaces these must be scraped, rinsed and sundried. The knives and hand tools must be cleaned with detergent and rinsed.

If water supplies are available in reduced amounts the cleaning programme may consist of:

- **scraping off solid waste with shovels and/or sweeping with brooms**
- **prerinsing with cold water**
- **manual washing with cold or lukewarm water/detergent**

- **rinsing with cold water**
- **sundrying of surfaces or disinfection with hypochlorite**

Example no. 2

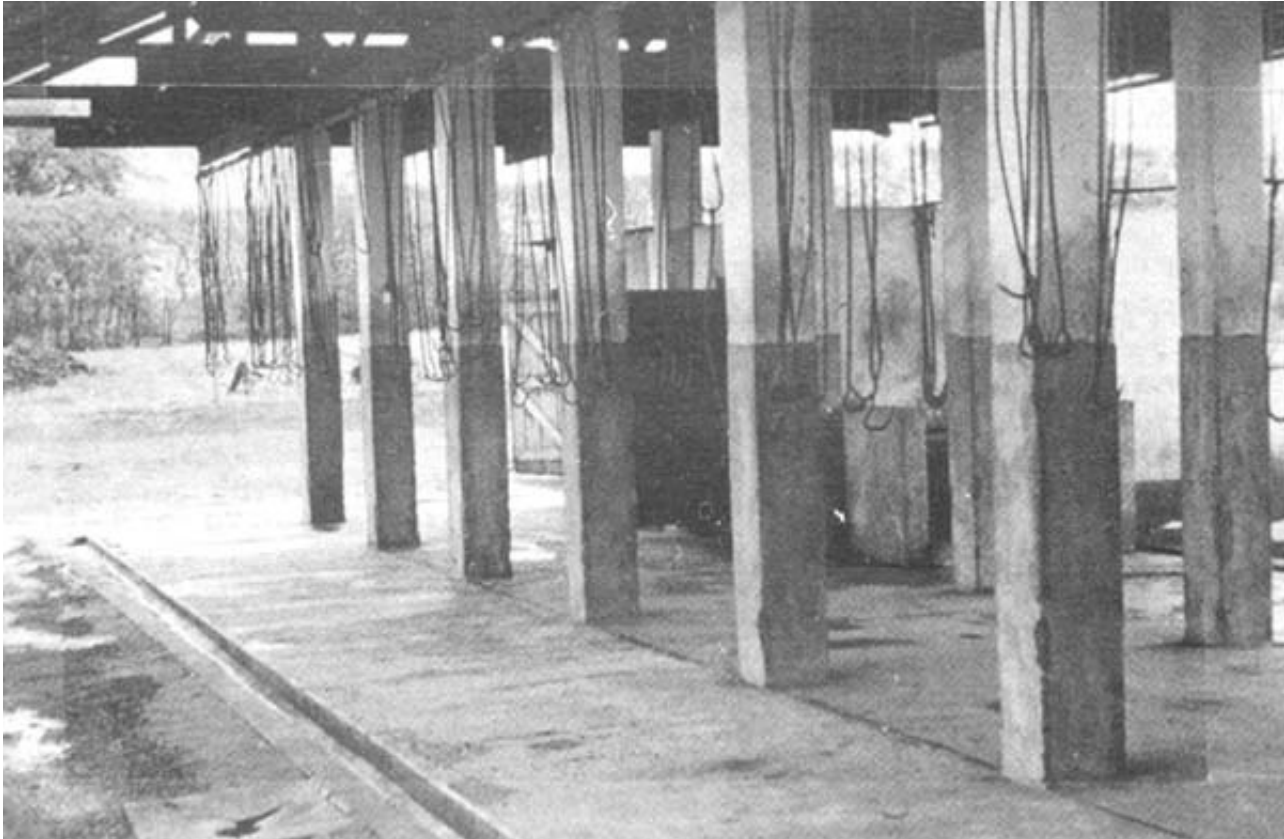
Conditions: Slaughterhouse in a sunny climate. The buildings are open in construction and may or may not be roofed. The supplies of energy and water are restricted. Figs. 11 and 12 show slaughterhouses of open construction.

Fig. 11. Slaughterhouse of open construction, but roofed. (Photo by S. Gade Christensen)



Fig. 12. Slaughterhouse of open construction, showing

arrangements for hoisting. (Photo by S. Gade Christensen).



Available water must be reserved for cleaning of knives and hand tools and handwashing.

If more water is available but in a restricted amount, the cleaning programme may consist of:

- **removing solid waste from surfaces by scraping with shovels and/or sweeping with brooms etc.**
- **manual cleaning (with brushes and cold/lukewarm water/detergent using the two-pail system)**
- **rinsing with clean water - if possible**
- **drying of surfaces or disinfection with hypochlorite**

It is important that the detergents used for cleaning do not leave unwanted residues on surfaces when the water amount for rinsing purposes is restricted. The detergent must be chosen

with care to avoid unwanted residues. Alternatively the working up can be done with clean water.

Example no. 3

Conditions: Slaughterhouse in a temperate climate. The buildings are constructed to protect against different climatic conditions.

Sufficient energy and water supplies are available.

The cleaning programme may consist of:

- **removing solid waste from surfaces using brooms and shovels**
- **prerinsing with cold water using a low pressure cleaner (20 bar)**
- **application of detergent (dosage according to suppliers'**

instructions) using a low pressure cleaner with an injector for intake of water, detergent and air. Water temperature 55°C. Pressure 5 bar

- **rinsing with warm water (40°C) using a low pressure cleaner (20–30 bar)**
- **disinfection with 200 ppm chlorine using a garden spray**
- **post rinsing with water of potable quality using a low pressure cleaner**

7.5 Conclusion

Referring to 7.1 and 7.4 there may be a difference between the ideal and the practical cleaning programme due to actual conditions.

The ideal cleaning programme has evolved in developed

countries where water and energy supplies normally are available in sufficient amounts. However, even here, the actual cleaning programme will still differ - often very much - from the ideal cleaning programme, because of:

- **insufficient management and education concerning cleaning,**
- **a practical programme which may differ from the proposed programme due to local conditions**

Practical programmes may be developed for use in developing countries which may differ totally from the ideal cleaning programme. Nevertheless, the practical programme may give better hygienic results than an ideal cleaning programme due to local conditions.





8. CONTROL OF CLEANING AND DISINFECTION

The cleaning and disinfection programme may be controlled by visual or bacteriological methods. If visual control is used it must be done in a systematic way and personnel must be especially trained. However, neither visual nor bacteriological control will individually give enough information on cleaning and disinfection efficiency but if used at the same time or at different times (staggered) it will be possible to evaluate the efficiency of the cleaning and disinfection programme.

8.1 Visual control of cleaning standard

The purpose of visual control is to note if the surfaces are clean. If they are insufficiently cleaned, then visual control will inform

on:

- a. The type of contamination**
- b. The seriousness of the contamination**
- c. Whether dry or wet surfaces should be controlled**
- a. The measures to be taken to remove the contamination may differ depending on the type of contamination (i.e. types of soil, see 4.1).**
- b. It is important to know if the contamination has to be removed immediately to secure hygienic production, or if it will be sufficient to remove the contamination by planned periodical cleaning or a special cleaning procedure.**
- c. Dry or wet surfaces are estimated in different ways concerning the degree of contamination. It is easier to find**

contamination (soil) on dry surfaces than on wet surfaces. Therefore it must be decided if the control will be carried out on dry or wet surfaces. Standards for dry and wet surfaces shall be laid down. Results from dry and wet surfaces must never be compared without adjustments.

When establishing a visual control procedure, the main task is to establish a common language of reference and to define an acceptable level of visual standard among the personnel whose work should be controlled. The acceptable level of visual standard may also vary between the different areas and different equipment in the slaughterhouse.

It is recommended that visual control is standardized, perhaps by filling out preprinted forms. If several persons from time to time do the visual control, they must have common training to avoid great differences in the evaluation level.

8.2 Other control measures

It may be convenient to control:

- **working routines**
- **working clothes**
- **personal hygiene**
- **environment**

The working routines of the cleaning procedures should be controlled to assure that the planned routines are respected. Otherwise the routines may change into less optimal (less hygienic) routines.

Working clothes should be controlled to assure a certain hygienic level. Staff must be controlled that they do not use the

working clothes outside the processing area.

Personal hygiene should be controlled, especially hand-washing. Good personal hygiene habits should be encouraged by correct and sufficient installations (hand-washing basins, toilets/latrines and bathrooms (showers)).

Appropriate personal hygiene should be enforced. However, since hygiene is often considered as personal, it should be done tactfully.

A solution may be to impress on the staff the need for good hygiene habits perhaps by a few short lessons, e.g. when a person starts employment, and also via encouragement and enforcement of good hygiene habits (see Appendix 1).

8.3 Bacteriological control

A simple and relatively accurate method to check the number of

microorganisms on equipment or surfaces is the agar sausage method.

The equipment which is necessary for this method consists of:

Sterile agar sausages, diameter 40 mm (media-types: plate-count and MacConkey agar in artificial casings)

Sterile Petri dishes (diameter 9 cm)

Sterile plastic bags

Sterile knives

Gas or spirit burner

Marker

The agar sausage method can be used for all sorts of equipment,

e.g. conveyors, tables, hooks, knives etc.

Technique: The cut surface of the agar sausage is pressed lightly against the surface of the equipment which has to be checked. In this way a stamp of the bacteria on the surface of the equipment is transferred to the sterile surface of the agar sausage. The stamped surface is sliced off (0.5 cm thick slice) with the sterile knife and transferred to the sterile Petri dish (the exposed surface upwards). The knife should be sterilized before a new sample is taken. Three slices (stamps) are taken from each piece of equipment. A normal size Petri dish can take 3 slices. The Petri dishes should be properly marked with code nos., dates, etc. before they are placed in the sterile plastic bags (to avoid dryness) and incubated at room temperature for 2 days.

Interpretation of results: after 2 days' incubation the number of bacterial colonies are counted. The number indicates the bacteriological cleanliness of the checked equipment and gives a

good impression of the efficiency of cleaning and disinfection.

The following can be taken as a guide:

xxx = more than 100 colonies on 3 slices

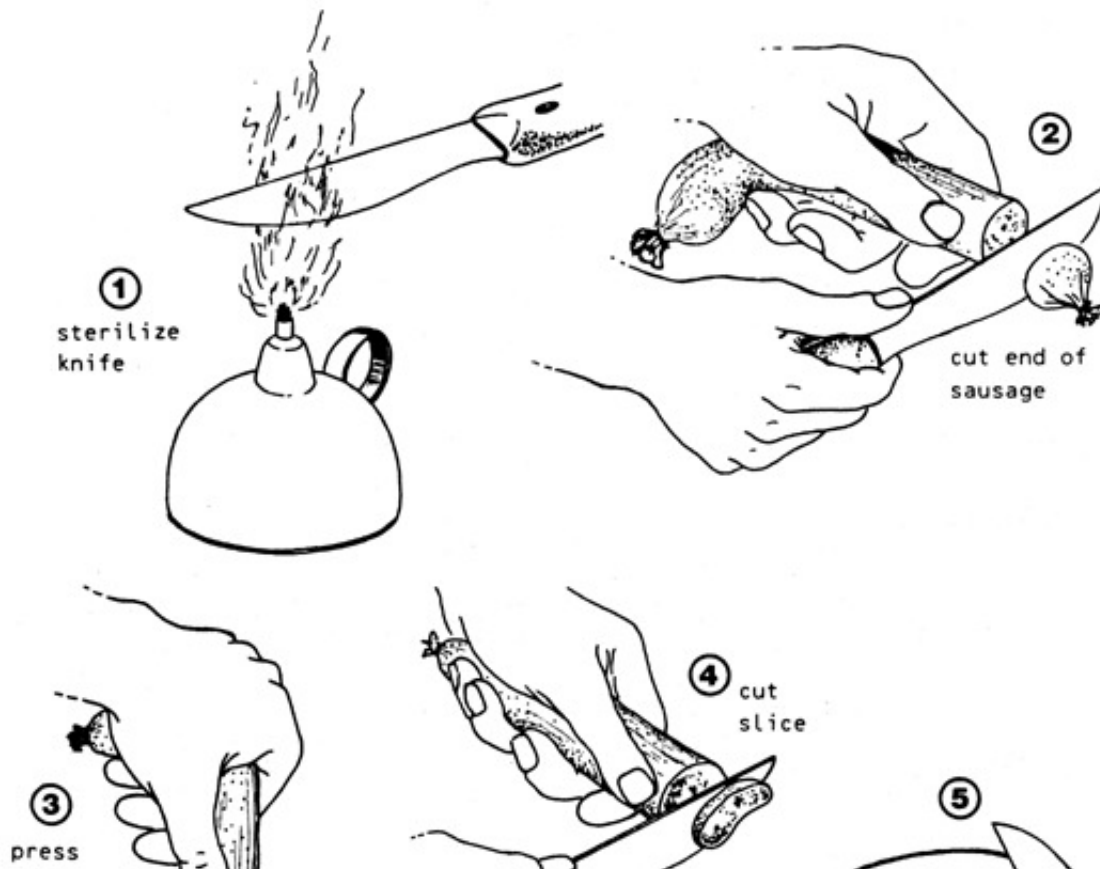
xx = more than 100 colonies on 2 slices

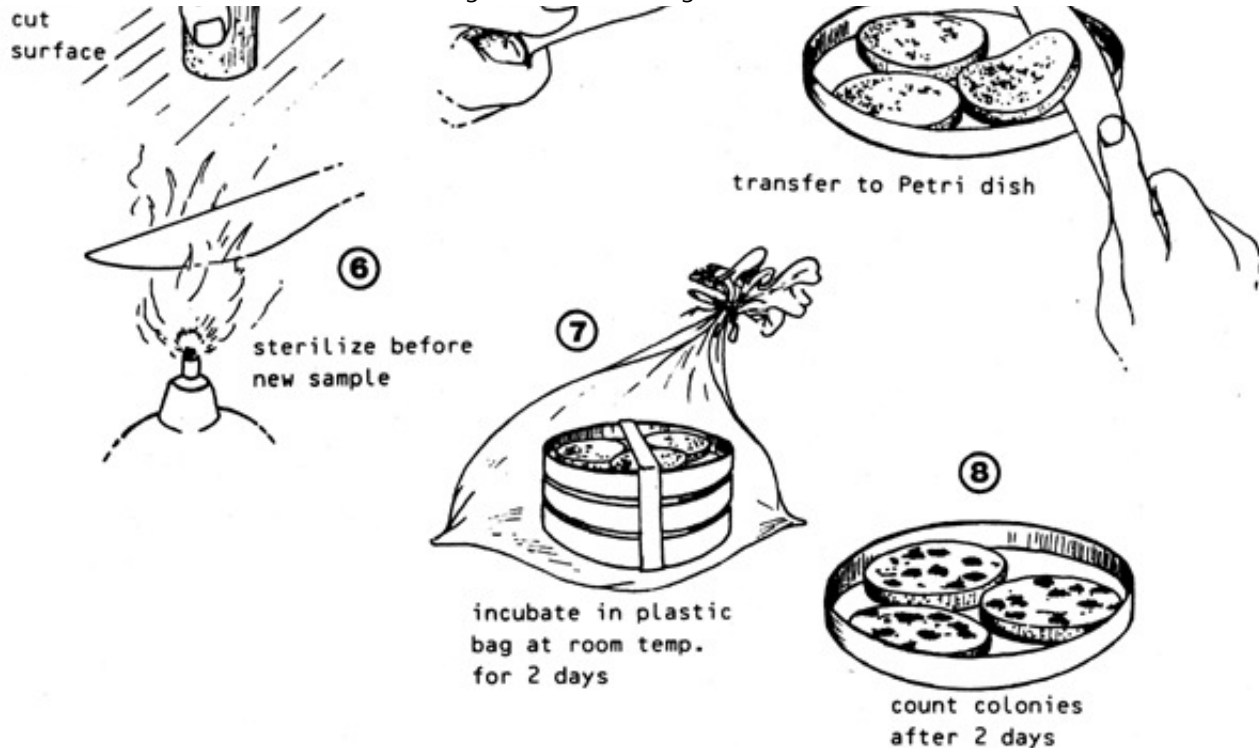
x = more than 100 colonies on 1 slice

- = less than 100 colonies on 3 slices

As a guideline none of the 3 agar slices should develop more than 100 colonies if cleaning and disinfection of equipment has been efficient

Fig. 13 shows the principle when using the agar sausage method for bacteriological control.

Fig. 13. The agar sausage method



This guideline depends on the type of production. The limit of 100 colonies may be too low if the control is taken on surfaces in the dirty area of a slaughterhouse but the limit of 100 colonies

may be too high if the control is carried out on knives used for heat-treated meat.

The management of a slaughterhouse/slaughter facilities will have to plan bacteriological control by deciding:

- **where it will be appropriate to take the samples**
- **how often it will be necessary to take samples**
- **how the samples must be taken**
- **how many colonies will have to be accepted in different rooms and on different equipment**
- **who will take the samples. It should be recommended that the person taking samples as far as possible is independent of the working routines**

The agar sausage technique has been further developed resulting in:

- **the contact plate method**
- **the agar slide method**

These methods are based on the same principle as the agar sausage technique but the surface area differs. To compare results from different methods it may be convenient to calculate the number of colonies per cm². It may be practical just to use one method and then lay down the acceptable number of colonies for different areas.

Other techniques may be used, but further facilities concerning laboratories and qualified staff will be required.

8.4 Conclusion

Both bacteriological and visual control will give the management of a slaughterhouse much information on the hygienic standard. If both methods are used and the results are evaluated together, it will probably reveal more quickly the points where hygiene must be improved. In other words, the results from bacteriological control will reveal requirements for disinfection and those from visual control requirements for an improved cleaning process.



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*** This publication contains a number of references related to
cleaning and disinfection in slaughterhouses and the meat
processing industry**

Appendix 1

REQUIREMENTS AND AIMS OF EDUCATION

**Information, skills, and/or attitudes to be acquired by
slaughterhouse personnel through education and/or training**

- **Understanding that their work must be conducted in a
hygienic way as it is essential to produce meats and meat
products which are safe for the consumer public**

- **Awareness, throughout their working time, that they are working with food products**
- **Understanding the consequences of possible mistakes during processing and cleaning procedures (e.g. which might cause unintended contamination)**
- **Understanding the necessity of personal hygiene and the significance of frequent hand-washing**
- **Knowledge of procedures for cleaning of knives, other utensils and work surfaces must be well understood and practised**
- **Motivation to collaborate with inspectors and technicians in the cleanliness of operations and of premises**
- **Understanding the need to inform managers/inspectors of any symptoms of disease**

- **Understanding that the personnel themselves can become infected during the handling of meat or in close association with animals and the means by which such infections can be avoided**

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