

MEAT HYGIENE



Kavita Marwaha

Meat Hygiene

"This page is Intentionally Left Blank"

Meat Hygiene

Editor

Dr. Kavita Marwaha



2007

Gene-Tech Books

New Delhi - 110 002

2007, © Publisher

Information contained in this work has been published by Gene-Tech Books and has been obtained by its author(s)/editor(s) from sources believed to be reliable and are correct to the best of their knowledge. However, the publisher and its author(s) make no representation of warranties with respect of accuracy or completeness of the contents of this book, and shall in no event be liable for any errors, omissions or damages arising out of use of this information and specifically disclaim any implied warranties or merchantability or fitness for any particular purpose.

All rights reserved. Including the right to translate or to reproduce this book or parts thereof except for brief quotations in critical reviews.

ISBN 81-89729-77-2

Published by : GENE-TECH BOOKS
4762-63/23, Ansari Road, Darya Ganj,
NEW DELHI - 110 002
Phone: 41562849
e-mail: genetechbooks@yahoo.co.in

Printed at : Tarun Offset Printers
Delhi

PRINTED IN INDIA

Preface

Meat forms a considerable component of the diet of a large number of people around the world, especially in developed countries. With the outbreak of new diseases like bird flue, meat hygiene has come to gain immense prominence as a matter of utmost prominence among consumers nutritionists and food technologists.

The main concerns of any meat consumer lies in meat safety and quality. With new advancements in technology, the meat packaging industry has gained a strong food hold in terms of the quality of meat it provide to customers, and it has begun to begun the ones of the burden of complying with standard regulations regarding meat quality.

This book describes the numerous kits, procedures, instruments and systems employed in the hygiene control of meat. For anybody who handles food as part of their work, meat is an inevitable commodity, and its hygiene forms a crucial part of their study in houses and training. Comprehensively exploring the issue, the book should be of great use to such personnel.

Editor

"This page is Intentionally Left Blank"

Contents

<i>Preface</i>	<i>v</i>
1. Introduction	1
2. Meat Sanitation	20
3. General Hygiene Principles for Meat Handling	64
4. General Hygiene Rules for Meat Industries	70
5. Red Meat Hygiene	77
6. Meat Products	119
7. Meat Cutting and Utilization	136
8. Hygiene Practices in Slaughtering and Meat Handling	164
9. Basic Techniques in Meat Processing	185
10. Animals Symptoms of Disease	220
11. Packaging and Labelling	233
<i>Bibliography</i>	267
<i>Index</i>	269

"This page is Intentionally Left Blank"

1

Introduction

Meat is a good source of protein and vitamins and minerals, such as iron, selenium, zinc, and B vitamins. It is one of the main sources of vitamin B12, which is only found in foods from animals, such as meat and milk. Some types of meat are high in fat, particularly saturated fat, which can raise cholesterol levels. Having high cholesterol increases the chances of developing heart disease.

When you're buying meat, the type of cut or meat product you choose (and how you cook it) can make a big difference. For example, a lean pork leg joint, roasted medium, typically contains one quarter of the fat of a pork belly joint with fat, grilled (5.5g fat per 100g and 1.9g saturated fat, compared with 23.4g fat per 100g and 8.2g saturated fat). Lean rump steak, grilled, contains half the fat of rump steak with the fat, fried (5.9g fat per 100g and 2.5g saturated fat compared with 12.7g fat per 100g and 4.9g saturated fat). The fat content of beef mince can also vary widely.

Fried chicken breast in breadcrumbs contains nearly 6 times as much fat as chicken breast grilled without the skin (12.7g fat and 2.1g saturated fat compared with 2.2g fat per 100g and 0.6g saturated fat). Try to go for the

leanest option whenever you can. As a general rule, the more white you can see on meat, the more fat it contains. So, for example, back bacon has less than half the fat of streaky bacon. Making healthier choices when buying meat

- Ask your butcher for a lean cut.
- If you're buying pre-packed meat, check the label to see how much fat it contains and compare products.
- Go for turkey and chicken, without the skin, because these are lower in fat.
- Try not to eat too many meat products such as sausages, salami, pâté and beefburgers, because these are generally high in fat. They are often high in salt too.
- Remember that meat products in pastry, such as pies and sausage rolls, are often high in fat.

If you're trying to have less fat, it's a good idea to cut off any visible fat and skin before cooking because fat, crackling and poultry skin are much higher in fat than the meat itself. Here are some other ways to reduce fat when you're cooking meat:

- Grill meat rather than frying.
- Try not to add extra fat or oil when cooking meat.
- Roast meat on a metal rack above a roasting tin, so fat can run off.
- Try using smaller quantities of meat in dishes and more vegetables, pulses and starchy foods.

Meat Storing

The goal of home food storage is to provide food that is

both safe and of high-quality. A food may have good quality in terms of appearance and taste but have a high bacterial count and be unsafe to eat. Thus it is important to follow safe handling and storage practices. Storage does not improve the quality of any food, nor will it cause a significant decrease as long as the food is stored properly and used within the recommended time. Since bacteria frequently get into food through careless food handling, it is important to keep everything—hands, refrigerator, freezer and storage containers—clean. Follow these tips for purchasing and storing top-quality foods that have been handled safely.

- Look for packages of food that are not torn or broken.
- Refrigerated food should feel cold (40°F or less), and frozen food should be frozen solid. Purchase these foods last.
- When shopping, place packaged raw meat, poultry and fish in plastic bags and keep from contact with other foods. (The raw juices may contain bacteria that could contaminate other foods.)
- Take perishable foods home quickly to refrigerate. If travel time will exceed an hour, pack fresh meats in a cooler with ice and keep in the passenger area of the car in warm weather.
- At home, refrigerate perishable food immediately. The “DANGER ZONE” for most food is between 40 to 140 °F. Bacteria grow most rapidly in this range of temperatures, doubling in number in as little as 20 minutes.
- Keep the refrigerator temperature between 32 to 38°F; the freezer at 0 °F or colder.

- Plan to use meats within three to five days after purchase, ground meats or seafood within one to two days, or freeze them.

Refrigerating

- Place meats and seafood immediately in the coldest part of the refrigerator or freezer when you get home from the grocery store or seafood market.
- Keep raw meats and seafood separate from cooked or ready-to-eat foods to prevent cross-contamination.
- Store fresh meat or fish in airtight containers or wrap in cling wrap and place on the bottom shelf of the refrigerator on a plate or tray to prevent leakage.
- Store shrimp, squid and shucked shellfish in a leak-proof bag, plastic container or covered jar.

Special precautions need to be made in storing live shellfish and preventing cross-contamination with other foods. Refrigerate live clams, oysters, mussels, crabs, lobsters and crayfish in well-ventilated containers. Cover the container with a damp cloth or paper towel. Do not store live shellfish in water or in airtight bags or containers where they could suffocate and die. Storing live shellfish in salt water shortens their shelf life. Storing them in fresh water kills them. Keep live shellfish alive.

Do not cook or eat shellfish that have died during storage. Live clams, oysters and mussels have tightly closed shells, or the shells will close when tapped. Live crabs, lobsters and crayfish move their legs. Dead shellfish spoil rapidly and develop off-flavours and off-odors.

Recommended times for refrigerator and freezer food storage

FOOD	REFRIGERATOR	FREEZER
MEATS, FRESH		
Beef roasts, steaks	3-5 days	6-12 months
Chicken or turkey, pieces	1-2 days	9-12 months
Chicken or turkey, whole	1-2 days	1 year
Duck or goose, game birds	1-2 days	6 months
Giblets	1-2 days	3-4 months
Ground meat or stew	1-2 days	3-4 months
Lamb, roasts or chops	3-5 days	6-9 months
Pork roasts, chops	3-5 days	4-6 months
Pre-stuffed pork and lamb chops or chicken breasts	1 day 1-2 days	* 1-2 months
Sausage	1-2 days	3-4 months
Variety meats: heart, liver, tongue, etc.	3-5 days	6-12 months
Venison, roasts, steaks, chops		
MEATS, COOKED		
Smoked breakfast sausage	7 days	1-2 months
Whole ham (fully cooked)	7 days	1-2 months
Half ham (fully cooked)	3-5 days	1-2 months
Ham slices	3-4 days	1-2 months
Canned ham ("keep refrigerated" label)	6-9 months	*
Hotdogs, luncheon meats (unopened)	2 weeks	1-2 months
Hotdogs, luncheon meats (opened)	3-7 days	1-2 months
Leftover meat	2-3 days	2-3 months
Leftover gravy and meat broth	1-2 days	2-3 months
Leftover poultry	2-3 days	4-6 months
Leftover chicken nuggets or patties	1-2 days	1-3 months

SEAFOOD, FRESH

Fresh lean fish: cod, flounder, trout, haddock, halibut, pollack, perch	1-2 days	4-6 months
Fresh fatty fish: mullet, smelt, salmon, mackerel, bluefish, tuna, swordfish	1-2 days	2-3 months
Live crabs and lobster same day purchased	2-3 days	*
Live mussels and clams	7-10 days	*
Live oysters	1-2 days	3-4 months
Freshly shucked mussels and clams	5-7 days	3-4 months
Freshly shucked oysters	2-3 days	4 months
Shrimp	2-3 days	1-2 months
Squid, whole	3-4 days	3-4 months
Squid, cleaned	2-3 days	3 months
Scallops	3-4 days	2 months
Smoked herring	5-8 days	2 months
Smoked salmon, whiting		

COOKED SEAFOOD

Crab, lobster, shrimp	2-3 days	2-3 months
Fish sticks, commercial	*	18 months
Breaded shrimp, commercial	*	1 year
Home-cooked fish portions	2-3 days	3 months

*Storage not recommended due to safety or quality issues.

Store frozen meat and seafood products immediately in the freezer when you get them home. Store them in their original moisture- and vapour-proof packages at 0 °F or below. It is safe to freeze fresh meat, poultry or fish directly in over-wrapped supermarket trays, but this type of wrap is permeable to air. For long-term storage, overwrap the packages with airtight heavy-duty foil or

freezer wrap using either the drugstore wrap or the butcher wrap. This will help prevent freezer burn in which the surface of the meat becomes light coloured and dried out, resulting in a tough, dry and less flavourful product. Be sure to press the air out of the package before freezing, and label for ease in selection for later use.

Defrosting

Never defrost foods in a garage, basement, car, plastic garbage bag, out on the kitchen counter, outdoors or on the porch. These methods can leave your foods unsafe to eat. There are three safe ways to defrost food: in the refrigerator, in cold water or in the microwave. It's best to plan ahead for slow, safe thawing in the refrigerator. Small items may defrost overnight; most foods require a day or two.

For large items like turkeys allow 24 hours for each 5 pounds of weight. For faster defrosting, place food in a leak-proof plastic bag and immerse it in cold water. (If the bag leaks, bacteria from the air or surrounding environment could be introduced into the food. Tissues can also absorb water like a sponge, resulting in a watery product.) Check the water frequently to be sure it stays cold. Change the water every 30 minutes. After thawing, refrigerate the food until ready to use.

When microwave-defrosting food, plan to cook it immediately after thawing because some areas of the food may become warm and begin to cook during microwaving. Holding partially cooked food is not recommended because any bacteria present wouldn't have been destroyed.

Refreezing

Once food is thawed in the refrigerator, it is safe to

refreeze it without cooking, although there may be a loss of quality due to the moisture lost through defrosting. After cooking raw foods that were previously frozen, it is safe to freeze the cooked foods. And if previously cooked foods are thawed in the refrigerator, you may refreeze the unused portion. If you purchase previously frozen meat, poultry or fish at a retail store, you can refreeze if it has been handled properly.

Cooking Frozen Meat

Raw or cooked meat, poultry or casseroles can be cooked or reheated from the frozen state. However, it will take approximately one and a half times the usual cooking time for food which has been thawed. Remember to discard any wrapping or absorbent paper from meat or poultry. Some frozen meat and poultry products such as pre-stuffed whole birds, must be cooked from the frozen state to ensure a safely cooked product.

Meat Cooking

It's very important to cook meat properly to make sure that any harmful bacteria have been killed. Otherwise you might get food poisoning. Bacteria can be found all the way through certain meat. So this means you need to cook the following sorts of meat until the juices run clear and there is no pink or red left in them:

- poultry and game such as chicken, turkey, duck and goose
- burgers and sausages
- kebabs
- rolled joints

But you can eat whole cuts of meat that are still pink inside, as long as they have been properly sealed. This

means you can eat whole cuts of beef, lamb and pork when they are pink or rare. This is because any bacteria are generally on the outside of the meat so if the outside is cooked, this should kill any bacteria, even if the middle of the meat is still pink. These include:

- steaks
- cutlets
- joints

Meat and poultry may carry *E. coli*, *Salmonella*, *Campylobacter*, *Toxoplasmosis*, *Trichinella spiralis*, and *Listeria*. Fish and seafood may carry *Vibrio cholerae* and hepatitis A. Thorough cooking is required to kill these disease-causing agents. The only way to know if meat is thoroughly cooked is to take the temperature of the meat. The correct end point temperature will destroy disease-causing bacteria depending on:

- Cooking time
- Number of bacteria present
- Bulk of product
- Type of bacteria

The bulk of the meat determines the amount of time required to achieve the temperature needed to kill disease-causing bacteria to a large extent. Different types of meat have different safe temperatures, because they may have different types of bacteria.

When cooking a whole turkey or chicken, the internal temperature at the thickest part of the thigh should reach a minimum of 180°F. Stuffing is safest if cooked outside the bird. If the bird is stuffed, the centre of the stuffing must reach 165°F. Individual drumsticks, thighs and wings should be cooked until they reach an internal

temperature of 180°F. Individual turkey and chicken breasts should reach 170°F.

Fish should be cooked until it reaches 145°F at its thickest point. It should be opaque and flaky when tested with a fork. Raw shrimp should turn pink. Lobster should turn bright red. The length of time required to achieve these temperatures will depend on:

- The amount of meat and the size of the pieces being cooked.
- Whether the meat is cooked from the fresh, thawed or frozen state.
- The cooking method (frying, roasting, boiling).
- Type of equipment used for cooking (oven, crock pot, stew pot, grill).
- Additional ingredients cooked with the meat (potatoes, stuffing, etc.).

Other points to cook meat safely include:

- Turn meat over at least once during grilling.
- Reheat pre-cooked meat to 165°F.
- If you cook meat from frozen state, add 10-20 minutes cooking time per pound.
- Never brown or partially cook meat and then refrigerate.

Safety Tips

1. Cleanliness

- Always wash hands thoroughly with soapy water before preparing foods and after handling raw meat.

- Don't let raw meat juices touch ready-to-go foods either in the refrigerator or during preparation.
 - – Do not wash or rinse raw meat, poultry or seafood. This avoids spreading bacteria around the kitchen. Cooking these foods to a safe internal temperature will get rid of any bacteria present.
 - Don't put cooked foods on the same plate that held raw meat. Always wash utensils that have touched raw meat with hot, soapy water before using them for cooked meats.
 - Wash counters, cutting boards and other surfaces raw meats have touched. These surfaces may be sanitised by cleaning with a solution of 1 teaspoon chlorine bleach per quart of water.
2. *Thawing*: Thaw uncooked meat in the refrigerator or in cold water. Never thaw meat at room temperature.
 3. *Marinating*: Marinate food in the refrigerator, not on the counter. Discard the marinade after use because it contains raw juices, which may harbor bacteria. If you want to use the marinade as a dip or sauce, reserve a portion before adding raw food.
 4. *Partial Cooking or Browning*: Never brown or partially cook meat, then refrigerate and finish cooking later, because any bacteria present would not have been destroyed. It is safe to partially precook or microwave meat immediately before transferring it to a hot grill or oven to finish cooking.

5. *Cooking*: Use a food thermometer EVERY time you cook raw foods; reheat leftovers; and hold hot, cooked foods for serving.
6. *Serving*: Hold hot foods above 140 °F and cold foods below 40 °F. Never leave foods, raw or cooked, at room temperature longer than two hours. On a hot day with temperatures at 90 °F or warmer, this decreases to one hour.
7. *Leftovers*: Always use clean utensils and storage containers for safe storage. Divide large amounts of leftovers into small, shallow containers for quick cooling in the refrigerator. Avoid placing large pots of gravy or stew in the refrigerator to cool since it will likely take until the next day for this amount of food to cool. To store in the refrigerator, wrap cooked meat in plastic wrap or aluminum foil, or store it in a tightly covered container and use within two to three days. For frozen storage, wrap meat in heavy duty aluminum foil or freezer paper and use within two to three months. If you may have kept the food refrigerated for too long, throw it out. Never taste food that looks or smells strange to see if you can still use it.
8. *Reheating Foods*: Reheat thoroughly to a temperature of 165°F or until hot and steaming. Soups and gravies should be brought to a rolling boil.

Food Thermometer

One of the critical factors in controlling bacteria in food is controlling temperature. Pathogenic microorganisms grow very slowly at low temperatures, multiply rapidly in mid-range temperatures, and are killed at high temperatures. For safety, food must be cooked thoroughly. It is essential to use a thermometer when

cooking meat to take the guesswork out of cooking and to assure that a safe temperature has been reached to destroy harmful bacteria such as Salmonella and E.coli O157:H7.

Using a thermometer is the only reliable way to ensure safety and to determine the “doneness” of most foods. To be safe, a product must be cooked to an internal temperature high enough to destroy any harmful bacteria that may have been in the food. A thermometer should also be used to ensure that cooked foods are held at a safe temperature (below 40 °F or above 140 °F) until served.

Recent research has shown that colour and texture changes are not reliable indicators that all bacteria have been destroyed. For example, ground beef may turn brown before it has reached a temperature that will destroy bacteria. A consumer preparing hamburger patties and depending on colour changes in the meat to determine safety is taking a chance that pathogenic microorganisms may survive. A hamburger patty cooked to 160 °F, regardless of colour, is safe.

The temperature at which different pathogenic bacteria are destroyed varies, as does the “doneness” temperature for different meat and poultry products. A roast or steak that has never been pierced in any way during slaughter, processing or preparation and has reached an internal temperature of 145 °F is safe to eat. A consumer depending on colour as a sign of doneness, might continue cooking it until it was overcooked and dry. A consumer using a thermometer can be assured that the food has reached a safe temperature. A food thermometer can help:

- Prevent foodborne illness;
- Cook foods to a safe temperature;

- Prevent overcooking; and
- Hold hot, cooked foods safely.

There are several types of food thermometers available at grocery, hardware or kitchen supply stores. The type of thermometer determines when it should be inserted in the meat. Make sure the thermometer you buy is designed for meat and poultry, not for candy or appliances.

- *Regular, Ovenproof Types:* These go into the food at the beginning of the cooking time and can be read easily.
- *Instant-Read and Digital Types:* These are not intended to go in the food in the oven, but give you a quick reading when inserted into the cooked food, and can be read easily.
- *Pop-Up Types:* These are commonly found in poultry, but may be purchased for other meats.
- *Microwave-Safe Types:* These are especially designed only for microwave ovens.

When you insert the thermometer will be determined by the type, ovenproof or instant-read. The important thing is to use a food thermometer, no matter how the food is prepared—roasted, broiled, fried.

- An ovenproof thermometer may be inserted into the food at the beginning of the cooking time and remain there throughout cooking. The temperature indicator will rise slowly as the food cooks.
- Instant-read thermometers are not designed to stay in the food during cooking. If you are using an instant-read thermometer, pull the meat or poultry out of the oven far enough to insert the stem about 2 inches into the thickest part of the food but not

touching bone. The temperatures should register in about 15 seconds.

Before using a food thermometer, read the manufacturer's instructions. The instructions should tell how far the thermometer must be inserted in a food to give an accurate reading. Most thermometers also come with instructions on how to recalibrate the thermometer. If instructions are not available, check the stem of the thermometer for an indentation, or "dimple" that shows how deep it must penetrate the meat to get an accurate reading.

Most digital thermometers will read the temperature in a small area of the tip. Dial types must penetrate 2 to 3 inches into the food. Most thermometers available will give an accurate reading within 2 to 4 °F, if the thermometer is placed in the proper location in the product. If inserted incorrectly, or if the thermometer is placed in the wrong area, the reading will not accurately reflect the internal temperature of the product.

In general, the thermometer should be placed in the thickest part of the food away from bone, fat or gristle. For whole poultry, insert in the inner thigh. When the food being cooked is irregularly shaped, such as may be the case with a beef roast, check the temperature in several places.

Tips for thermometer use

- Use an "instant-read" thermometer to check patty temperatures. They are designed to be used toward the end of cooking time and register a temperature in about 15 seconds.
- If a meat patty is not thick enough to check from the top, insert the thermometer in sideways.

- The thermometer should penetrate the thickest part of the food.
- To check the calibration, place the stem in ice water as described below. Most thermometers have a calibration nut under the dial that can be adjusted.
- Wash the thermometer after each use.

Most pathogenic bacteria are destroyed between 140 °F and 160 °F, but the recommendations for “doneness” varies for the type of meat or poultry. Ground meats must be cooked thoroughly to kill harmful bacteria. Unlike whole muscle meat, which is sterile inside, the grinding process exposes the interior meat to bacteria on the surface, in the air, on equipment or on people’s hands. To kill these bacteria, food safety experts have one major rule of thumb, which is to cook ground meat to at least 160 °F. This simple step offers the best protection that consumers can have to serve ground products safely.

Minimum internal temperatures ensure that foodborne bacteria have been destroyed. For reasons of personal taste or texture preferences, consumers may choose to cook meat and poultry to higher temperatures.

145 °F	Beef, lamb and veal steaks, roasts and chops cooked medium rare (cooked medium to 160 °F). Fish.
160 °F	Egg dishes. Ground beef, veal and lamb. Pork, all cuts.
165 °F	Leftovers. Poultry. Stuffing and casseroles.

A food thermometer can be checked for accuracy using either the ice water method or the boiling water method. The ice water method is explained below. Many food thermometers have a calibration nut under the dial that can be adjusted.

Ice Water Method: To use the ice water method, fill a large glass with finely crushed ice. Add clean, cold tap water to the top of the ice and stir well. Immerse the food thermometer stem a minimum of 2 inches into the mixture, touching neither the sides nor the bottom of the glass. Wait a minimum of 30 seconds before adjusting. (For ease in handling, the stem of the food thermometer can be placed through the clip section of the stem sheath and, holding the sheath horizontally, lowered into the water.)

Without removing the stem from the ice, hold the adjusting nut under the head of the thermometer with a suitable tool and turn the head so the pointer reads 32 °F. Even if the food thermometer cannot be calibrated, it should still be checked for accuracy. Any inaccuracies can be taken into consideration when using a food thermometer, or it can be replaced. For example, ground beef patties must reach 160 °F. If the thermometer is reading two degrees too high, two degrees would be added to the desired temperature, meaning hamburger patties must be cooked to 162 °F.

Cooking with Microwave

It is difficult to cook food evenly in the microwave. These tips will help you produce a safe, high quality product.

- Use only microwave safe cookware.
- Debone large pieces of meat. Bone can shield the meat around it from thorough cooking.

- Cook large pieces of meat on medium power (50%) for longer times. This allows heat to conduct deeper into meat without overcooking outer areas.
- Stir or rotate food once or twice during microwaving, and turn large food items upside down so foods cook more evenly and safely.
- Do not microwave whole, stuffed poultry. Cooking of meats is so rapid, the stuffing inside might not reach a sufficient temperature to be safe.
- When microwaving unequal size pieces of meats, arrange in a dish or on a rack so thick parts are toward the outside of the dish and thin parts are in the centre. Cook on medium-high or medium power.
- Add liquid.
- Place a roast in an oven-cooking bag or in a covered pot for safe, even cooking.
- Refer to the manufacturer's directions that accompany the microwave oven for suggested cooking times.
- Remove from microwave and test for doneness in several places with a meat thermometer, or use a microwave-safe meat thermometer during cooking.
- Observe standing times so cooking is completed.
- Never partially cook food. When microwaving food to finish cooking on the grill or conventional oven, transfer the microwaved food to another heat source immediately.

Unfortunately, colour is not a reliable indicator of properly cooked meat. In fact, meat may appear brown before it is fully cooked, especially for whole cuts of meat.

On the other hand, some meat may look pink even when it is fully cooked. Many things can affect the colour of meat in addition to whether it is cooked thoroughly or not. For instance, the amount of fat may affect the meat's colour and so can vegetables cooked with meat. Pathogens may be outside or inside the meat, so internal temperature is important and the only way to know for certain that it has been cooked safely.

2

Meat Sanitation

Proper sanitation is important, not only from the standpoint of protecting human health and providing food that is unadulterated with filth or foreign matter, but also from the standpoint of good manufacturing practice, in that proper sanitation will result in an improved keeping capacity for meat products, fewer customer complaints and a generally more acceptable product in the market place.

Facilities and Equipment

These are the fundamental or basic units upon which plant management builds or creates an atmosphere conducive to the production of safe and aesthetically acceptable meat products. An excellent sanitation programme begins with facilities and equipment that are found acceptable as to construction, maintenance and performance. The maintenance of satisfactory sanitary standards depends upon a regular programme of cleaning, washing and where necessary, sanitising, to preclude and remove unwanted contaminants such as bacteria, flaking paint, rust, dust, etc.

This is the responsibility of plant management, and the inspection responsibility consists of confirming that

the management has effectively performed its role. Plant sanitation personnel must be familiar with the breakdown and daily cleansing of equipment, utilised within a particular establishment. Inspection personnel should also familiarise themselves with critical areas, critical equipment and critical areas within the equipment.

Housekeeping Practices

Housekeeping practices form an integral part of a sanitation programme. This will include such actions as garbage collection and disposal, janitorial service during operations, storage and maintenance of equipment temporarily not in use, removal from production areas and storage of obsolete equipment, etc. Poor housekeeping practices may and do encourage the harbouring of bacteria, mould, yeasts and rodents and thus negate cleaning and sanitising of equipment. Contamination can be transferred through contact with employees, trucks, equipment and in the ambient air. A high standard of housekeeping leads to and is an adjunct of an excellent sanitation programme.

Use of Water

Water Chlorination

- 1) Where automatic chlorinators are used in a registered establishment, it is essential that management establish procedures to ensure water potability. Two controls which are fundamental, are as follows:
 - a) A metering device for adding chlorine in the correct concentration, relative to the waterflow rate, designed to readily indicate malfunction.

- b) At least twice daily, tests shall be made to determine the total available chlorine level at a specific point, remotely located from the chlorine application site, but before distribution to the plant system. An automatic analyser, equipped with a recorder and alarm system may be utilised as an alternative to the above testing.
- c) Hyper-chlorination in poultry plants
- d) Hyper-chlorination in red meat plants

Analyses for Potability of Water and Ice

Analyses may be performed at provincial or municipal public health laboratories or at private laboratories. Private laboratories, including laboratories at registered establishments, can only be used if they have obtained recognition from the provincial authorities having relevant jurisdiction (where that service is provided). If such a recognition service is not provided, the first two options are to be used.

Water

Establishments using only municipal water, require bacteriological analyses on a semi-annual basis with satisfactory results. Establishments supplementing municipal supplies with water from private wells or using solely water from private wells, require bacteriological analyses on a monthly basis with satisfactory results. Whenever a sample is submitted for bacteriological analyses, enumeration of coliforms per 100 ml and total plate count shall be requested.

Ice

Establishments manufacturing ice on site require

bacteriological analyses of this ice on a semi-annual basis with satisfactory results or more often as needed. The ice sample shall be taken from the site most likely to cause contamination. Enumeration of coliforms per 100 ml and total plate count shall be requested. Bacterial specifications for ice are as for water. If the testing indicates ice made at the plant is out of compliance all of this ice is held, disposed of and a different source of ice is sought. It is important to identify the cause of the contamination.

The water supply to the ice machine shall be tested immediately and if in compliance with the bacterial specifications a clean-up and sanitation of all the ice equipment is required (ice room, chutes, ice machine etc.). Following this clean-up, the newly made ice shall be tested and must comply with the specifications before the ice can be used. Establishments purchasing ice from an outside supplier must test the ice for enumeration of coliforms per 100 ml and total plate count (or have the supplier provide a certificate of potability which includes the bacterial results) whenever there is a change in the supplier company, and a minimum two times a year if the ice is from a municipal water source or monthly if the ice is made from other than a municipal water source (eg: well water).

If bacterial testing of the supplied ice indicates that bacterial specifications are not met, the ice must be held and disposed of. The supplier is notified and the next 3 lots from this same supplier must be tested or come with a certificate of potability which includes the bacterial results.

- 1) *Chemical analysis*: Water obtained from municipal supplies need not be sampled at establishments since chemical analysis is carried out at the source.

Water from private wells shall be subject to at least one initial chemical analysis with a satisfactory result. The need for any further sampling will be determined by the Chief, Programme Development and Evaluation – Chemical Residues, after consultation with provincial health authorities.

- 2) *Water sample collection for analysis:* Plant management is responsible for the collection and shipment of samples in a satisfactory manner. The site of collection should be varied from sample to sample to provide a maximum coverage of water outlets within the registered establishment. Sterile containers for the collection of samples and instructions regarding shipment should be supplied by laboratories performing the analyses. Samples for bacterio-logical and chemical analysis shall be collected in appropriate containers. Chlorinated water for bacteriological analysis must be collected in containers with a neutralising agent, normally 10% sodium thiosulphate solution used at the rate of 2 ml per litre of water. When samples for chemical analysis are being submitted, they should preferably be collected at the end of the spring runoff or immediately following an extended period of wet weather.
- 3) *Acceptable methodology:* Analysis may be performed at provincial or municipal public health laboratories or in provincially recognised private laboratories.
- 4) Minimum acceptable bacteriological standards
 - a) *Coliform count:* The objective level is no coliforms per 100 ml of water. However, water may be adjudged bacteriologically acceptable provided the following tolerances are not exceeded:

- i) no sample contains more than 10 total coliforms per 100 ml of water;
- ii) not more than 10% of the samples taken in a 30 day period show the presence of coliform organisms;
- iii) not more than 2 consecutive samples from the same site show the presence of coliform organisms; and
- iv) none of the coliform organisms detected are faecal coliforms

If any coliform organisms were detected, another sample shall be taken from the same site. If the presence of coliforms is confirmed, action shall be taken to determine the cause.

- b) *Total bacterial count*: The objective level is less than 500 organisms per ml. The result should be used as an indicator for quality control in comparison with other test results on record. A sudden rise over previous levels should be followed up by additional sampling and by an investigation to identify the source of the problem. In addition, excessive concentration of the general bacterial population can hinder the recovery of coliforms and thereby prevent the detection of a potential threat to public health. Most laboratories do not automatically test for total counts, but will provide this service if requested. Total counts provide a valuable aid in assessing water quality, and shall therefore be requested.
- 5) *Chemical standards*: Chemical analysis should be carried out for substances listed in Tables 1 and 2. The range of chemical analyses will depend on

local conditions, such as geological formation, seepage from soil treated with fertilisers, pesticides or local exposure to industrial pollution. To establish the range of tests or repeats required, local Public Health authorities and municipal water plants should be consulted by the Director, Food Inspection. In cases of doubt, the Chief, Programme Development and Evaluation—Chemical Residues, should be consulted.

Table 1. Recommended Limits for Chemical Substances related to health

<i>Substance</i>	<i>Maximum Acceptable Concentration mg/L</i>	<i>Objective concentration mg/L</i>
<i>Inorganic</i>		
Antimony	—	0.0002
Arsenic	0.05	0.005
Barium	1.0	0.1
Boron	5.0	0.01
Cadmium	0.005	0.001
Chromium	0.05	0.0002
Cyanide (Free)	0.2	0.002
Lead	0.05	0.001
Mercury	0.001	0.0002
Nitrate (as N)	10.0	0.001
Nitrite (as N)	1.0	0.001
Selenium	0.01	0.002
Silver	0.05	0.005
Sulphate	500.	150.
Uranium	0.02	0.001
<i>Organic</i>		
Nitrilotriacetic Acid (NTA)	0.05	0.0002
Pesticides (Total)	0.1	—
Trihalomethanes	0.35	0.0005

Table 2. Recommended Limits for Pesticides

Pesticides	Maximum Acceptable Concentration mg/L	Objective Concentration mg/L
Aldrin Dieldrin	0.0007	5x10 ⁻⁸
Carbaryl	0.7	5x10 ⁻⁴
Chlordane (Total Isomers)	0.0007	5x10 ⁻⁸
DDT (Total Isomers)	0.03	5x10 ⁻⁸
Diazinon	0.014	1x10 ⁻⁶
Endrin	0.0002	1x10 ⁻⁸
Heptachlor Epoxide/Heptachlor	0.003	1x10 ⁻⁸
Lindane	0.004	1x10 ⁻⁶
Methoxychlor	0.1	5x10 ⁻⁸
Methyl Parathion	0.007	1x10 ⁻⁶
Parathion	0.035	1x10 ⁻⁶
Toxaphene	0.005	5x10 ⁻⁸
2. 4D	0.1	1x10 ⁻³
2.4.5-TP	0.01	1x10 ⁻³
Total Pesticides	0.1	—

- 6) *Physical characteristics*: Potable water should be clear, without offensive taste and odour.
- 7) *Reporting of test results*: Test results should be reported giving bacterial and chemical levels found. In addition, the laboratory should provide a statement to the effect that the water is adjudged to be potable or non-potable, on a bacteriological/chemical basis. If the laboratory does not provide this statement, then it will be the responsibility of the inspector in charge to assess the test results. If there is any doubt regarding this assessment, the inspector should contact his regional office for advice. A report of coliform organisms, even if less than 10/100 ml, shall initiate an immediate resampling. Inspectors should review the results with plant management. Certificates for water

potability must be retained by management of the registered establishment for 3 years and be available to the inspection staff.

- 8) *Action if limits are exceeded:* When a test result indicates limits are exceeded, follow-up sampling shall be initiated immediately by plant management, consisting of one or more samples taken on three (3) consecutive days. If all samples taken on three consecutive days are negative, weekly sampling for a period of three (3) weeks is to be continued. Two positive test results during followup sampling in the 4 week period make it necessary that remedial action be taken. This may consist of; switching to a noncontaminated source, trucking in potable water, or chlorination or other chemical treatment as indicated.

Steam

Steam which may come in contact with product or with product contact areas shall be generated from potable water. The steam supply must be able to meet operational requirements. The manufacturer shall have records to demonstrate the microbiological and chemical safety of the water used to produce the steam supply. Boiler treatment agents must be approved, used according to the manufacturers directions and do not lead to product contamination.

Role of Plant Managements

Implicit in the act of receiving a License to Operate a Registered Establishment is a commitment by the operator to provide facilities and equipment which meet the meat hygiene standards outlined in the Meat Inspection Act & Regulations, to maintain facilities and

equipment in a sanitary condition and to ensure that all processing activities conducted within the establishment are performed in a sanitary manner and comply with Good Manufacturing Practices (G.M.P.'s).

It is required that the operator of each registered establishment compile his programme(s) regarding sanitation activities, pre-operational inspection and employee training (employee sanitation and sanitary food handling practices) in a written document which is maintained in an up-to-date manner and is available to the inspector upon request.

The manufacturer has a written cleaning and sanitation programme for the entire premises. This programme must include all pre-operational and operational procedures and be dated and signed by a plant official having authority. The operator of a registered establishment shall develop, implement and maintain a sanitation programme for all equipment and facilities. In cases where the operator cannot comply with the minimum requirement of washing equipment and facilities with soap and water on a daily basis, he shall make an application to the Chief, Meat Processing Inspection Programmes. The application shall have annexed thereto :

- a) justification for not doing a daily wash
- b) a copy of the sanitation programme
- c) the scientific data proving the effectiveness and the safety of the proposed sanitation programme compared, where applicable, to the results obtained when doing a daily wash of equipment and installations.

When satisfied that the sanitation programme for which an application has been made is effective and safe, the

Chief, Meat Processing Inspection Programmes could authorise its use.

The sanitation programme shall be kept in written form, signed and dated by the individual with overall authority on-site or an official of the registered establishment. The sanitation programme shall contain :

- (a) the name of the person(s) responsible for carrying out the programme,
- (b) the measures taken to ensure that the building, equipment, utensils and all other physical facilities of the registered establishment are maintained in a sanitary condition before and during the operations,
- (c) the frequency of the cleaning and sanitising activities,
- (d) the equipment and chemical agents use to bring about and maintain clean and sanitary conditions,
- (e) the concentration, temperature and other specifications for the detergent, sanitiser or other chemical agent used, and
- (f) the monitoring activities put in place by the operator to ensure the effectiveness of the sanitation programme, including procedures conducted before the start of operations.

The written sanitation programme must provide sufficient guidance to ensure that staff responsible for sanitation activities are aware of their responsibilities and have the tools and techniques required to perform sanitation activities in a satisfactory manner. The sanitation programme document must be kept up-to-date in order to reflect current activities in the plant. Responsibilities for sanitation activities and the resources

allocated (example: training needs of sanitation staff) for these activities are to be set out in the written programme. Plant management should appoint designated employee(s) to be responsible for plant sanitation.

The sanitation programme shall incorporate cleaning schedules and methods that will assure an adequate level of performance. The programme specifies the following: areas to be cleaned, method of cleaning to achieve the required efficiency (chemical concentration, application procedures and equipment, contact time, etc.), person responsible, frequency of activity. It addresses food contact surfaces and equipment, specialised cleaning equipment for a particular equipment (e.g., injectors, grinders, cleaning-in-place, vehicles,...), floors, drains, walls, ceilings, lighting fixtures, refrigeration units, overheads and anything else impacting on food safety. This scheduled sanitation programme can be developed in parallel with the preventative maintenance activities for equipment, overheads and other items requiring routine refurbishing and other like attention.

It must be understood that the inspector's responsibility is limited to verifying that the sanitation programme is delivered in a manner consistent with the operator's written programme and that the programme is effective in achieving meat hygiene programme objectives with regard to sanitation. Monitoring of the effectiveness of the sanitation programme is the responsibility of plant management. In addition to pre-operational inspection, checks for effectiveness of the sanitation programme shall be instituted.

Work procedures, chemical preparation and application procedures and other sanitation activities shall be verified by a plant management representative

on some basis to assure themselves that the written programme is being followed. Microbiological methods as a verification of the effectiveness of the sanitation programme should be used, e.g., swab tests contact plates, ATPase tests, Total Plate Count, etc., at a frequency necessary to demonstrate adequacy. The operator of a registered establishment shall retain, for not less than one year after the date of the activity or procedure, written or electronic records that include information on:

- a) the monitoring activities and pre-operational procedures, including the results of any test, and
- b) any corrective action taken.

Preoperational inspection of the plant shall be conducted by a responsible employee to ensure that operations only begin after sanitation requirements have been met. The written programme must explain how the preoperational programme works, e.g., authority of responsible employee doing the preoperational inspection, responsibilities for ordering corrective action, responsibility for verifying corrective actions, use of reporting forms. Pre-operational inspection activities must be documented and these documents must be available to the inspector upon request.

When deficiencies are identified during the preoperational inspection, they must be noted and acted upon. The corrective action taken (eg: immediate correction, schedule for later action) shall be indicated on the daily preoperational inspection report, and if immediate correction is required, the corrected item will be verified before use and this verification entered into the report. The inspector-in-charge's responsibility is to verify that the plant managements documented

programme is executed as described and that operations are conducted in a sanitary environment. It is not the inspector's role to conduct regular preoperational inspection for the operator.

Employees must understand the risks associated with contamination of food by microbiological or chemical agents. Employees must be shown the ways to avoid the contamination of the product and they shall be given the proper equipment to achieve this goal. Training activities must be described in a written employee training programme. Employee training must be appropriate for the complexity of the manufacturing process and the tasks assigned. All food handlers must be given appropriate training in personal hygiene and hygienic handling of food at the beginning of their employment.

Additionally, all personnel involved in HACCP systems must be appropriately trained to understand the importance of any critical control point (CCP) for which they are responsible, the critical limits, the procedures for monitoring, the actions to be taken if the limits are not met and the records which are to be kept. Task specific training shall also be outlined in the training document. Sanitation employees and supervisors must be appropriately trained to understand the principles and methods required for effective cleaning and sanitising.

Shipping and receiving staff must be trained in proper carrier inspection and product handling procedures. Maintenance staff must be appropriately trained in hygienic practices and to identify deficiencies that could affect product safety and to take appropriate corrective action. Employees responsible for monitoring and calibration activities are also to be trained in proper procedures. Additional training is to be provided whenever changes in equipment or processes dictate

updating of procedures. General updates and reinforcements of training at appropriate intervals shall also be included in the training programme.

To demonstrate that the written preoperational and operational sanitation, inspection and training programmes are being delivered according to the written plans, the operator shall maintain written records of these activities. The records shall demonstrate the effective monitoring and control of these activities. Whenever a deficiency has been identified, it should be noted along with the corrective action taken to resolve the problem. Sanitation records shall be kept on-site for at least one year and be available to the inspector on request.

Role of the Inspector

Inspectors are responsible for reviewing and approving the sanitation programme developed by plant management. They are further responsible to monitor the implementation of the sanitation programme carried out by plant management. The implementation of control programmes by the inspector will be greatly improved if a spirit of cooperation can be developed with a plant management which recognises the benefits that accrue from an adequate sanitation programme.

Action must be initiated by the inspector where plant and equipment sanitation is found unsatisfactory. The type of action may vary from a simple request for rectification of a deficiency to suspension of operations in a room or even an entire establishment. The action must be based on the magnitude of the problem and the associated risk to the integrity of product.

Control Mechanisms

Control mechanisms must be implemented whenever

there is a justifiable and identified need. However, they should be applied in a uniform and consistent manner. It is not possible to describe or delineate all the control mechanisms or procedures that may be utilised in the monitoring of a plant's sanitation programme. Those we implement have been developed through a practical application of check systems that assure an environment suitable to the production, handling and processing of a wholesome meat product.

The frequency and severity of application have a direct relation to the degree of risk involved, the past history of compliance and possible changes or variations in operating procedures. Control should not be limited to those systems that have been historically developed in the field of meat hygiene but should be viewed as a dynamic and challenging opportunity to review the packing house environment as it relates to the production of acceptable products, with a view to developing modified or new procedures that will facilitate the monitoring of a sanitation programme. It is imperative to review a control mechanism or procedure based on the three questions as follows:

- Is it necessary?
- Is it effective?
- Should it be modified?

A positive analysis and response to these three questions tend to assure the credibility of a monitoring programme.

Types of Contaminants

A control programme in this area of sanitation requires a knowledge and understanding of the total environment in which meat products are handled. It further requires keen observation and constant review to assure that

environmental influences have not arisen that could adversely affect the acceptability of the product. Look up, look down and look around, and examine the product itself.

Paint, Dust, Rust, Condensation and Disintegrating Insulating Material

The above is a partial listing of contaminants or hazards. This type of contamination can fall on or into product, equipment and packaging material. The sanitation programme requires an ongoing campaign of good maintenance which will eliminate peeling paint, dust, rust, condensation and disintegrating insulating materials. Where overhead structures are so affected, it may be necessary to restrict the use of a room or an area. Equipment so affected must be withdrawn from use, until brought back into a satisfactory state.

Metal Contaminants

Staples used for box forming operations are a real source of contamination. Box forming operations shall not be performed in close proximity to open containers of meat. Tag fasteners or skewers must be removed after serving their function and before carcasses are cut or boned. At no time are cleaning aids such as wire brushes or steel wool, to be used on meat products. It is further understood that they are not to be used in production areas of a registered establishment, when meat products are present.

Metal contaminants may come from a multitude of other sources and may include the following: friction of metal hooks on overhead rails, beads and pieces of slag from welding equipment, poorly welded equipment, broken and worn equipment, can openers and containers, metal hangers, loose strapping, wires, etc.

The use of metal detectors should be encouraged in order to alert all concerned to the presence of metallic foreign material. The presence of metal in meat product is a serious situation which calls for a careful review of meat handling practices from slaughter through shipping of the product. Every effort must be expended to establish the source of the problem in order to rectify same. Certain equipment and substances which generate gases or odours may have received approval for use from the Meat and Processed Animal Products Division.

In many instances this approval has been conditional on a particular location, venting system or use. Other types of equipment such as mechanised vehicles do not require such approval. Inspectors must satisfy themselves that, in the case of the former group, the conditions are complied with and that in all instances the use of equipment and substances does not create a hazard to personnel, nor to meat products.

Other Types of Contaminants

These may include, but are not restricted to, the following: broken glass, packing paper, packing film, wood splinters, etc. Prevention consists of forbidding the use of glass, other than the product containers, in a processing area, the adequate defrosting of meat blocks in order to preclude the retention of wrapping paper and plastic films; assuring that the internal surfaces of meat transport vehicles are intact and free of wood splinters, that wooden skewers are not used as neck pins, etc.

Any type of contamination requires a serious investigation on the part of management, in cooperation with inspection personnel, to establish the cause and to rectify same. Only those cleaning agents, disinfectants, protective oils and lubricants which are listed in the "Reference Listing of Accepted Construction Materials,

Packing Materials and Non-Food Chemical Products" may be used. Where necessary, there must be adequate rinsing off of cleaning agents and disinfectants, and in addition, equipment surfaces subject to food contact must have all protective oil removed prior to use.

Care must be taken that machinery and equipment lubricants do not contact or enter edible products in any manner. Much will depend on the placement of equipment such as motors. Plant maintenance personnel must be made aware of their responsibility in this facet of their work.

Packaging Materials

Only those packaging materials which are listed in the "Reference Listing of Accepted Construction Materials, Packing Materials and Non-Food Chemical Products" may be used. Unlisted packaging materials may contain toxic ingredients that may migrate to meat food products. It is further required that the use of packaging materials be constantly reviewed from a functional standpoint. They must protect the product and not disintegrate, tear, etc. and thus, in themselves, become a contaminant.

Cardboard containers must be stored and handled in a manner that minimises contamination with dust, etc., and prevents contamination with liquids. When packaging exposed meat products into unwaxed cardboard containers, liners must be used and every effort must be made to prevent the meat products from coming into contact with the exposed surfaces of the containers. When waxed cartons are used, contact with the external surfaces should be avoided. The packaging of exposed meat products into cardboard containers should not result in the external surfaces of the containers becoming stained with blood or fat.

Wooden Pallets

Essentially, wooden pallets are permitted for use primarily in freezers and dry storages. The restriction results from the fact that wood is pervious to liquids and therefore difficult to clean. It is, however, realised that pallets must be loaded, unloaded and moved into areas, other than freezers and dry storages. This means that adequate control and judgement must be exercised to maintain the pallets free of contamination and damage which can adversely affect the level of sanitation in an establishment. Plant management must ensure that pallets are in good repair and clean before use. In some cases, where problems are encountered, the use will require restriction or change to appropriate alternate equipment.

Volatile Substrates

Certain paints, floor sealants, etc. contain a volatile element which may transfer an odour or chemical contamination to meat products. It is essential that areas treated with such products be adequately ventilated during and after the drying period, before meat products are permitted to enter those areas. It is recommended that the areas be closed off for a few hours, then a check for odours be made to ensure that complete dispersion has occurred.

Pre-operational Inspection

Plant management is responsible for all aspects of quality control including the pre-operational inspection of all production areas. Management must assure that sanitary standards are met prior to permitting the commencement of operations. The Meat Hygiene personnel monitors the effectiveness of management's sanitation programme by

periodically conducting inspections of the premises, facilities and equipment.

The responsible inspector checks if control is being exercised over the environmental influences which may adversely affect meat or meat products processed therein. The frequency of monitoring of the sanitation programme will be based on the known credibility of management to assume and perform their responsibilities. Room temperatures where refrigeration is a requirement must be at a correct level before the commencement of operations. A room temperature should, at this stage, be below the required level, since the movement of personnel into the room, plus their own body heat and the operation of sanitisers will cause the room temperature to rise.

Product contact zones are of immediate importance and would include table surfaces, equipment e.g. saws, and the interior of equipment. The latter shall be dismantled for ease of cleaning and not reassembled for use prior to receiving a pre-operational sanitary inspection. Room surfaces such as floors, walls, ceilings and overhead fixtures are next in importance and must be maintained free of cracks and of rust, dust, and other extraneous material in addition to reasonable housekeeping practices. Condensation forming above product areas is not acceptable and this item must be covered on the pre-operational inspection.

The external and under-surfaces of equipment, such as product trucks, emulsifiers, mixers, etc., shall be examined for cleanliness. Such surfaces, if unclean, can serve as ready reservoirs for product contamination. The sanitation of employees' equipment, which may include knives, steels, hooks, mesh gloves, aprons, etc., is another responsibility of management.

Sanitisers must be checked for the ability to function correctly at the required temperature. It is to management's advantage to institute a check of effectiveness of their sanitation programme by the use of bacteriological methods of review: e.g., Millipore, Swab Test or total plate count. Where deviations from accepted norms are found, management shall initiate the required action to remedy the situation. If the problem is not corrected, the use of equipment and/or facilities could be denied.

Operational Inspection

In addition, this facet of sanitation is a challenge, in that due to the rapidity of production, unacceptable practices could result in vast amounts of product out of compliance. Equipment, practices or services could be at fault. The accumulation of proteinaceous material and fat on equipment over the course of a shift should be prevented as much as possible, but obviously this will occur within equipment in some locations where easy removal is not feasible.

In order to reduce the hazard posed by such situations, adequate and correct temperature regulation is essential in order to slow down the reproduction rate of microorganisms. Equipment such as sanitisers, hand washing facilities (including washrooms), etc. must be maintained in an acceptable fashion. Operating procedures, from the stunning of animals right through processing to shipping, must be performed with regard to alterations in the environment that would put the product at risk. Procedures must be constantly reviewed and examined for potential problems.

On the kill floor, areas of common contact should be identified and sanitation procedures instituted.

Prevention of contact with contaminated or diseased tissues is of prime importance. Management must supply the required janitorial service (floor cleaning, trash removal, scrap removal, etc.) to maintain a satisfactory level of hygiene during operations. Also of importance are the work habits, dress and personal hygiene of plant employees. The inspector must be aware of and capable of detecting potential problems. He is further required to assure himself that management will initiate action to resolve the problems.

Sanitisers and Sanitising Dips

Sanitisers, when strategically placed, maintained and utilised, become a very important facet of sanitation during daily operations. They must be sufficient in number and located where required. Plant management is required to assure that they are maintained and are functional prior to and during operations. Sanitisers must be operated at not less than 82°C with adequate water overflow, in order to achieve a sufficient reduction in the number of microorganisms present.

It must be remembered that the presence of organic matter on the equipment will act as a barrier, thereby protecting the micro-organisms. Equipment should therefore be as clean as possible before it is placed in a sanitiser. When a chemical sanitiser is used in lieu of an 82°C water sanitiser, the sanitising agent must be approved for this use and the manufacturers instructions on the label must be followed including contact time and rinsing or draining as applicable, and efficacy is demonstrated.

Hand sanitising stations (e.g., dips, gels, sprays, etc.) serve as purposeful adjunct to the hand-washing facilities located in processing areas. They are required and must

be used by all employees which come in direct contact with microbiologically sensitive meat products (ready-to-eat meat products). They must not be located where contamination of the product could occur. They may be located next to the hand washing stations and used after hands have been thoroughly washed or closer to the production line where no contamination of product or direct contact surfaces can occur.

The use of hand sanitising solutions must be restricted to those listed in the Reference Listing of Accepted Construction Materials, Packaging Materials and Non-Food Chemical Products. It is further required that they be used in keeping with directions on the label (eg: correct concentration, contact time). The hand dip solutions should be renewed throughout the day, as often as necessary, so that they, in themselves, do not become a source of contamination.

Caution must be exercised in that management and inspection personnel do not put excessive reliance on this aspect of sanitation, to the detriment of other sanitary control measures throughout the operations. Relaxation of sanitary requirements earlier in the production process cannot be offset by the ritualistic dunking of hands. Antibacterial soaps can be used in place of hand sanitising dips. These soaps must be listed in the Reference Listing of Accepted Construction Materials, Packaging Materials and Non-Food Chemical Products and be used according to the directions on the label.

Plastic gloves may be worn by employees which come in direct contact with ready-to-eat meat products as long as their hands are washed upon entering the processing area, prior to putting the gloves on, and their gloved hands are sanitised in an approved hand dip prior to handling product. For both chemical hand dips and

chemical equipment sanitisers, the operator must perform effectiveness checks (eg: necessary concentration, contact time) and keep records of these checks.

Exemption to Refrigeration Requirements

The following rules supersede and replace all previously existing exemptions to refrigeration requirements for processing rooms. Note that temperature requirements for storage rooms, curing rooms and non-production areas are not changed. Therefore, these rules do not apply to:

- Cooking rooms (e.g., oven, kettles, fryers, etc.);
- Fermentation and aging rooms;
- Transfer areas into and out of cook rooms (e.g. hallways where no product is kept);
- Kill floors, evisceration floors, scalding rooms and slaughter associated processes such as tripe, feet, casings, etc.

As a general rule, all meat product processing operations (including those for shelf stable dry cured meat products having “keep refrigerated” on the label) shall be conducted in refrigerated rooms (i.e., maintained at a temperature of 10°C or less). Exemptions from the requirement to maintain refrigeration (10°C) in processing rooms can be granted by a Regional Programme Manager, Meat Hygiene, if ALL of the following conditions (A,B,C and D) are met:

- a) The environment (equipment, contact surfaces, handlers,...) shall not pose a risk of product contamination at any time during operations. Each HACCP- based QC programme shall be reviewed and recommended by a team composed of the Inspector-in-Charge and a regional programme specialist having the required specialised

knowledge, then submitted to a Regional Programme Manager, Meat Hygiene. After appropriate review by the Regional Programme Manager, the programme will be stamped and returned to the operator with the reviewers' conclusions. The operator must keep any letter of acceptance on file for future reference and review by the Inspector-in-Charge. As each process will be inherently different, it is impossible to provide set microbiological guidelines suitable for all operations. Microbiological programmes will therefore need to be developed by the operator on a case by case basis to the satisfaction of the Regional Programme Manager, Meat Hygiene and shall demonstrate the safety of the environment at all times during processing.

- b) Any unclean equipment that was previously used and left unused for a period of 2 hours or more shall be completely taken apart, cleansed and sanitised before being reused;
- c) Unless the operator is able to demonstrate the continual microbiological acceptability of the environment, a complete mid-shift clean up of contact surfaces shall take place at least once every 4 hours during operations. Such a mid-shift cleanup procedure shall consist of removal of all meat products, other ingredients and packaging material from the room prior to conducting a thorough cleaning and sanitation of product contact surfaces. Should such cleaning create condensation on overhead structures, the condensate must be eliminated prior to the start-up of operations. At the end of a mid-shift clean-up, product contact surfaces shall meet the same criteria as for the pre-operational inspection stage.

d) The type of operation falls within one of the categories listed below.

– *Kitchen / Formulation operations:* An exception for the refrigeration of formulation rooms under specific circumstances has been made. Most meat products entering these rooms come directly from the cooler and are at a relatively low temperature. All formulation, stuffing, handling, pre-blending, marination, etc. operations involved in the processing of meat products are eligible for exemption from refrigeration requirements provided ALL of the following additional conditions are met:

- i) the meat used in the product was either hot boned immediately prior to processing OR previously chilled to a temperature of 4°C. or less, and
- ii) the meat surface temperature never exceeds 7°C; and
- iii) in the case of a non-cured product, cooking (product must be fully cooked), drying or fermenting of the product shall start within 2 hours of the time it first enters a non refrigerated area.
- iv) In the case of a cured product, cooking (product must be fully cooked), drying or fermenting of the product shall start within 4 hours of the time it first enters a non refrigerated area.

– *Comminuting operations:*

- i) Comminuting operations (e.g., grinding, emulsifying, dicing, slicing, chopping, etc. of raw meat products) are eligible for

exemption from refrigeration requirements provided ALL of the following additional conditions are met:

- i) The meat to be comminuted was previously chilled to 4°C or less and
 - ii) the comminuted product cooking cycle is initiated within 2 hours from the time the product enters a non refrigerated area.
- *Meat filled pasta/ meat filled pastries/ continuous line for breaded meat products:* The processing of meat-filled pastries and meat-filled pasta (e.g., ravioli, tortellini, etc.) that cannot technically be processed under refrigeration (because the dough will not stick together in a refrigerated area), as well as continuous lines for breaded meat products, could be allowed in a nonrefrigerated area provided ALL of the following conditions are met:
- i) the meat product has been chilled to a temperature of 4°C. or less before being transferred to the nonrefrigerated area AND the meat product surface temperature does not exceed 7°C. at any time during the process; and
 - ii) the product is either:
 - a) placed in a freezer within 30 minutes after the preparation is completed OR
 - b) fully cooked or pasteurised within 30 minutes after the preparation is completed and subsequently chilled or frozen.

- *Handling of pork tongues, pork hocks & feet intended for immediate further acidification:* Such handling could be allowed in a nonrefrigerated area provided ALL of the following conditions are met:
 - i) there is a continuous drop in product temperature as defined by the “Time/Temperature Guidelines for Cooling Heat Treated Processed Product”; and
 - ii) handling is done with all precautions being taken to avoid re-contamination of the cooked product (e.g. disposable gloves, use of hand sanitisers, restricted area, special ongoing sanitation of equipment as required, etc.).
- *Assembling and Packaging of meat products:* Different situations could occur with different levels of risk:
 - i) Packaging of cooked refrigerated (4°C or less) meat products shall be done in a refrigerated room (maximum temperature of 10°C) in order to minimise reheating of product surfaces and possible growth of pathogens.
 - ii) Packaging of frozen meat products in a non refrigerated room could be allowed if:
 - a) The product enters the nonrefrigerated room in a frozen condition; and
 - b) the product’s surface temperature does not exceed 0°C. while in the nonrefrigerated packaging room.
 - iii) Assembly and packaging of entrées, such as pizzas and TV dinners could be allowed in a

nonrefrigerated room provided ALL of the following conditions are met:

- a) The process is continuous in nature;
 - b) The meat product has been chilled to a temperature of 4°C. or less before being transferred to the nonrefrigerated area; and the product's surface temperature does not exceed a temperature of 7°C. at any time during the process;
 - c) handling is done with all precautions being taken to avoid re-contamination of the cooked product (e.g. disposable gloves, use of hand sanitisers, restricted area, special ongoing sanitation of equipment as required, etc.); and
 - d) The product freezing process is initiated within 30 minutes of the beginning of the assembly operation.
- iv) Packaging/handling of meat products which have just been cooked but have not yet been refrigerated to the storage temperature of 4°C or less, and the application of a surface coating or glazing to a cooked meat product (e.g., chicken wings, etc) at the exit of the oven could be allowed in a nonrefrigerated area provided ALL of the following conditions are met:
- a) packaging/handling operations are done while the product is still at 60°C or above;
 - b) packaging/handling operations in such a nonrefrigerated area do not interfere with the product cooling process; and

- c) handling is done with all precautions being taken to avoid re-contamination of the cooked product (e.g. disposable gloves, use of hand sanitisers, restricted area, special ongoing sanitation of equipment as required, etc.).
- Handling and packaging of dry soup mixes, bouillons, broths, concentrates, tallow, lard, suet, edible casing preparation, edible fat and shelf stable dry cured meats (if truly shelf stable i.e. the label does not have a “Keep refrigerated” statement): Because these products are shelf stable and represent a very low health risk, an exemption could be granted.

Please note that the handling (e.g., boning, picking, dicing, etc.) of warm cooked meat product when those products could be used as ready-to-eat products (e.g. diced chicken that could be used for salads) is not exempted and shall therefore be conducted in a fully refrigerated area. It should be remembered that unless the operator is able to demonstrate the continual microbiological acceptability of the environment (by means of a valid microbiological sampling programme), a thorough and complete mid-shift clean up (including equipment dismantling) and a preoperational check shall take place at least once every 4 hours of operations. Some discretion is permitted when dealing with enclosed equipment through which product is passing on an almost continuous basis, e.g. stuffers. In these instances, dismantling and cleaning may be permitted on a daily rather than a shift basis.

Mid-shift Clean-up

The only other case where a mid-shift clean-up procedure

is allowed in lieu of adequate refrigeration is when there has been a temporary mechanical failure of refrigeration equipment making it impossible to maintain the prescribed room temperature. In this case, measures must be taken to ensure that product temperatures do not exceed 10°C. This may be accomplished by icing, or other satisfactory means. In those cases where the prescribed room temperature cannot be maintained, a thorough cleanup must be made after each four hours of operation.

Such a mid-shift clean-up procedure must consist of removal of all meat products, other ingredients and packaging materials from the room prior to a thorough cleaning of product contact surfaces and a rinse down of floor areas. Should such cleaning create condensation on overhead structures, the condensate must be eliminated prior to the start-up of operations.

Outside Premises

This is an area which often does not receive the attention it deserves. The location of a plant in conjunction with the sanitation of the external premises has a bearing on sanitation with the premises. The standard of sanitation practised outside the premises may well be reflected in the attitude of plant employees within the establishment. Consistent implementation of good groundkeeping habits is required to prevent product contamination from objectionable odours, vermin, ash, dust, etc..

Programmes must be developed for the storage and removal of unwanted material. Suitable storage facilities must be provided for garbage which should be removed daily. Meat and bone scraps require proper containers and refrigeration to prevent a potential hazard from flies and bacteria. Unused and obsolete equipment, building materials, etc. must not be allowed to accumulate in

disarray but should be piled neatly and routinely removed if of no further use. Grass and weeds should be kept under control. The location of an incinerator, if permitted by local authorities, should be such that the prevailing winds do not direct the fumes or smoke toward the plant. The incinerator must be placed on a suitable concrete foundation and fitted with a screen to control the emission of flying ash.

Transportation

The vehicle used in the transport of meat products is technically an extension of the plant premises. When examined or considered in this light it is obvious that the vehicle acts as the interim storage facility from the plant to its point of destination. Acceptance of this premise dictates that construction, maintenance, sanitation and refrigeration standards must equate, as closely as is reasonably possible, to those standards required of the registered establishment. Management is required to assume the responsibility of providing satisfactory conveyance vehicles and mechanisms for the transport of meat product.

Inspection personnel are required to monitor this aspect of plant operations and are further empowered to deny the use of unsatisfactory vehicles and to hold for reworking or refuse entry to products received in unsatisfactory vehicles or which have been subjected to abuse, e.g., defrosting, contamination, etc. during transportation.

The vehicles and crates used to transport animals to slaughter play an important role, not only in the humane treatment of animals and the control of animal disease, but also in sanitation. In general, the cleaner animals are upon reaching the slaughter floor, the better the chances

of reducing contamination levels on dressed carcasses, assuming good dressing practices are put to use. To encourage those transporting animals to load them into clean vehicles and crates, it is important that a good example be set, by ensuring that all vehicles and crates leaving a registered establishment are cleaned and disinfected in accordance with the Health of Animals Act and Regulations.

Construction and design should be such that this area may be kept reasonably free of manure, straw, odour, etc., that may attract and harbour insect and rodent populations. Total sanitation is further enhanced through the provision of adequately lighted "held pens" for reactor and suspect animals in order to isolate them from other animals. A cleaning and disinfecting programme should be developed in keeping with the operations and disease control requirements, e.g., reactor pens to be cleaned and disinfected after each day's use or more frequently, if directed. Routine cleaning shall be performed as often as is necessary to meet the objectives as outlined above.

Good animal husbandry must be manifested in the provision of clean feed, water and bedding, where necessary. Implicit in good husbandry practices is the maintenance of the facility so that it is free of exposed nails, broken boards, floors, etc. that may injure the animals.

Disposal of Waste

It is preferable that waste such as paper, boxes, strings, etc. be removed from the plant premises on a daily basis. Properly identified containers designed for holding this material must be provided throughout the plant. Janitorial service is to be supplied, that will remove and replace these containers as often as necessary. Overflow

and spillage on the floor defeats their purpose. Attention to detail in this area of plant sanitation helps create an atmosphere and attitude that is reflected in employees' work attitudes. A sloppy work place begets sloppy work habits.

Waste materials within the livestock pens, such as manure and straw, may be collected and deposited on a hard surfaced slab for subsequent removal. A programme must be initiated for the routine removal of this material so as to prevent the possibility of its becoming a harbouring place for flies and vermin and giving rise to objectionable odours.

Disposal of condemned and other inedible meat products

Control of this aspect of packing house sanitation is of vital importance. Every effort must be made to assure that the storage and handling of these materials does not put edible products at risk. Segregation is the key to control. This is achieved through developing an acceptable flow system, so that inedible meat product is directed away from the edible meat product. Part of this system may be appropriately marked containers or chutes used to move product to the designated inedible and condemned product rooms of an establishment.

The identity of these products must be maintained at all times until they are used as animal food products or, in the case of condemned material, until they are subjected to a sterilisation process or disposed of in accordance with the Meat Inspection Regulations. These products should always move directly to their designated areas and should never be rerouted through the processing areas used for edible products. Odour in the plant from inedible operations may indicate an error in the pattern of air flow.

The equipment used for the handling of these products must be frequently cleaned and disinfected and any equipment returning into edible areas must first be cleaned. The storage areas or rooms must also be subject to a scrupulous cleaning and sanitising programme. This equipment and the storage facilities represent a very real sanitation hazard to the establishment, if not subjected to a rigid sanitation control programme.

Welfare facilities

The provision of adequate welfare facilities is an indispensable requirement for the promotion of hygienic practices. The quality of facilities provided to employees in this area of their work environment is so often reflected in their attitude and work habits relating to sanitation at the work stations. Attention must be paid to the size, lighting, ventilation, etc. These facilities must be maintained and provided with adequate janitorial service throughout the day. Close attention must be paid to the possible infestation with vermin, e.g., cockroaches. Failure to respond to the needs and standards in these areas may require withdrawal of inspection privileges until rectification of the deficiencies has been accomplished.

Personal Hygiene

Plant management is responsible for an ongoing educational programme that will inform all employees of their responsibilities in this aspect of sanitation. Management has a further responsibility of assuring that the requirements are being consistently met by their employees in the interest of the quality of the product and the well-being of their staff. The following is important in all areas where edible products or

ingredients are handled, prepared or stored and where equipment and utensils are washed.

Sanitary Work Habits

These shall preclude the use of chewing gum, snuff and tobacco in any form in production areas. Eating and drinking shall be confined to the designated lunch room areas, except that water from fountains may be consumed in production areas. Hands, including fingernails, shall be clean and shall be washed at all times after using the lavatory facilities. Hand wash facilities are to be located at the entrances to production areas and are used by everyone upon entering the food production/handling area.

By making these visible, thus enabling their use to be monitored, additional safeguards with respect to hand washing are provided. Scratching of the head, face, etc., or the placing of fingers in or around the mouth or nose are not acceptable practices. Care of the hands shall include the treatment and appropriate covering of all cuts and sores by the plant nurse or designated first aid employee.

The use of hand creams and lotions shall be restricted to and in keeping with the label instructions of those "Accepted for Use" by the Meat and Processed Animal Products Division. One must avoid the use of nail polish when handling edible product. Coughing, sneezing and spitting are non-acceptable practices. Furthermore, the operator shall ensure that no person in his registered establishment represents a risk of contamination by pathogenic microorganisms for the meat products or the surfaces with which meat products come into contact.

The Department's policy regarding work clothing is to prevent contamination of edible products by contact with

clothing of questionable cleanliness. In order to prevent this form of contamination, suitably washed and maintained work clothing must be substituted for or worn over any other piece of clothing that may contact food products. Work clothing must not be worn or stored in incompatible areas (washrooms, lunchrooms, lockers used for street clothing, outside the plant, etc.).

Employees that must enter areas of the plant which are incompatible (eg: barn/slaughter floor, maintenance staff) take appropriate measures to prevent cross-contamination (eg: coded smocks, cover garments). Employees in ready-to-eat product areas remove their outer garments before leaving the area and hang them in designated areas. Overalls are not considered to be acceptable work clothing for employees handling edible exposed meat products. Footwear should be of a design and material that is equal to the challenge of the work environment.

The eviscerator's boots, where he is working on a moving top table, shall be of a material impervious to moisture and shall be of a colour distinct from other footwear. These boots must be worn only at the work station. Other footwear must be utilised when walking to and from the work station. These boots, along with aprons, knives and associated gear, must be cleaned and sanitised in the adjacent boot cleaning compartment. Personal adornment and accessories to clothing such as jewelry, badges, buttons, create a potential risk to meat products and, at times, create a risk to the safety of the employee where moving equipment is involved.

All such items shall not be worn in food preparation and packaging areas. In these same areas, items such as pens, pencils, thermometers, etc., should not be kept in coat/shirt pockets where they may accidentally fall into

products. Jewellery items which cannot be removed such as continuous loop earrings, wedding bands, medic alert bracelets or necklaces, etc., also create a potential risk to the safety of the product and must be adequately covered.

Facial adornments that cannot be removed or are not removed because of any reason (e.g. religious, cultural, etc.), are items which have the potential to fall or otherwise contaminate the meat product if they are improperly attached. In view of the fact that these adornments pose a food safety hazard and that it is impracticable to verify if they are worn securely, they shall be either removed or adequately covered when worn in food preparation and packaging areas.

The proper use of hairnets or other appropriate headcover and gloves to cover personal adornments, or surgical masks in the case of facial adornments, would be considered adequate cover. A "bandaid", however, used to cover a wedding band is inadequate, as it cannot be cleaned and may become dislodged and further contribute to product contamination. Protective gear such as helmets, wrist guards, aprons, steel-meshed gloves, etc. must be of materials capable of being cleaned and maintained clean. All such equipment must be cleaned and sanitised immediately if they meet with gross contamination during operations (e.g., ruptured abscess during postmortem operations).

The use of cloth gloves is to be discouraged due to the fact that they rapidly become soiled and, subsequently, can easily contaminate meat products. Should cloth gloves be worn on the slaughter floor, tripe wash area or other similar operation, they must be covered by an accepted impervious material. The use of uncovered cloth gloves may be permitted only in boning and cutting or

similar operations, where safety may be a factor. However, such use should be minimised and, preferably, the gloves should be covered by an accepted impervious material.

However, if the policy of the operator is to change cloth gloves at every two hours of operation or less, and such a policy is effectively controlled by the operator, such use will be permitted. In cases where the use of cloth gloves cannot be effectively controlled by the operator and meat products are being contaminated, the use of such gloves will have to be denied or they will have to be covered by an accepted impervious material. The use of cloth gloves to handle exposed, ready-to-eat meat products is not permitted.

All persons working or entering areas where food products are open to exposure must wear appropriate head coverings, to prevent the contamination of the product through the introduction of falling hair. In order to achieve this, the head coverings must cover all exposed hair. If hairnets are used, the mesh must be small enough to adequately stop loose hair from escaping. Hairnets must also be used to cover all exposed facial hair with the sole exception of neatly trimmed moustaches. Head coverings must be maintained clean and be in a good state of repair.

Work clothing and equipment such as knives, hooks, steels, mesh gloves, etc. is preferably stored in a central location, at or near the work stations. At the end of operations, all such equipment should be cleaned and sanitised and be available for a pre-operational inspection. This control is weakened when such equipment is stored in each employee's locker. If security for personal working tools is required, separate lockers are preferable. If this equipment is stored away from the

work site a formal inspection procedure must be instituted to examine the equipment as it is brought into the production area.

Vermin Control

Satisfactory plant construction in keeping with an excellent housekeeping programme, along with the use of screens, air curtains, and electrical insect control devices are the first steps in avoiding the introduction of insects and rodents. Vermin, through their habits, are capable of introducing serious human diseases to food products.

Responsibility for Use

This rests with plant management. To this end, it is required that only licensed pest control operators or designated plant employees, under adequate inspection control, may prepare and use such materials.

Insecticides

These may be residual or non-residual. They may take the form of aerosols, sprays, powders, pellets, repellents or gases. Each may be specifically formulated for designated use and places. The inspection staff should be aware of the insecticides being used and of any potential restrictions for their use or application.

Rodenticides

These may come in dry form or liquid form and be presented in a variety of bait stations. It is imperative that these stations be identified and that a map of their location be in the possession of the inspection staff. It is important that these stations be adequately serviced and supervised. All stations must be of the covered variety.

All bait stations must be removed from edible product rooms and areas before the commencement of operations.

The inspection staff should be aware of the rodenticides being used and the location of bait stations throughout the plant. Management or their agents must provide the inspector in charge with a map locating every bait station, and provide a regular report on the control programme to the inspector in charge.

Hazardous Non-food Chemicals

There are occasions when hazardous non-food chemicals such as rodenticides, herbicides, etc. are stored in registered establishments. Such situations have the potential to lead to accidental misuse or contamination of meat products. Although correct labelling of all non food items is required, complete reliance cannot be placed on this as a control measure, owing to the varying degrees of literacy encountered amongst company employees.

1. Where feasible, hazardous non food chemicals are to be stored away from registered establishments and only required amounts be brought onto the premises under the direct supervision of a responsible company employee.
2. Such materials, if it is necessary to store them on the premises, are to be stored in a separate room or partitioned area of a storage room, under lock and key, with controlled access being given to a responsible individual or small group of company employees.
3. If either of the above is not possible, then such materials are to be stored, well separated from other non food items, in such a manner that accidental misuse or contamination is prevented.

4. Where hazardous chemicals are stored in a registered establishment, the use of a colour coding or similar type of system is strongly recommended to enable company personnel to identify different categories of product.

Since the amount of space available, alternative sites for storage, etc. will vary considerably between different establishments, it is the responsibility of inspection staff and plant managements to jointly review individual situations and where necessary, take action to ensure good control and security. All of the above measures are additional to, and not a substitute for, existing measures such as divisional acceptance, labelling and monitoring of use by inspection staff.

Non-meat Ingredients

Management must have written specifications for all non-meat ingredients to prevent biological, chemical and physical hazards in food. Storage of such products shall be maintained in designated dry storage areas or spice rooms in the establishment. Such areas or rooms shall be free of excessive moisture. Products of this nature are to be considered as edible products and shall be supported on racks or pallets in keeping with acceptable practices. A high standard of housekeeping is required in these areas.

It is further understood that non-food chemicals such as soaps, detergents, etc. shall not be stored in these areas. In addition every effort must be undertaken to store and secure these non-meat ingredients free from dust, rodents and insects. To this end it is recommended that properly designed and lidded containers be utilised where practical. Unwashed vegetables must be stored, washed and prepared in separate rooms and areas to prevent the introduction of contamination. The

inspector's responsibility in non-meat product handling areas is to ensure that a satisfactory environmental sanitation level is maintained, which will not jeopardise meat products. Actual production procedures, regulatory standards and labelling lie of our jurisdiction.

When opening containers such as bags, sacks, etc., care should be exercised so that this is performed away from the meat products to which their contents are to be added, in order to preclude the inadvertent admission of extraneous material such as string, sacking material, fibres of paper, dust, etc. This is in essence, the development of work habits and practices that lend themselves to the prevention of the introduction of extraneous material to the meat food products.

General Hygiene Principles for Meat Handling

Current recommendations for handling all meat products are to keep them clean, cold and covered in order to maintain quality and protect against food poisoning and disease. Generally contamination occurs when the product comes into contact with dirty hands, clothing, equipment or facilities. If the product is kept clean there will be little or no contamination by microorganisms whether bacteria, yeasts, moulds, viruses or protozoa or by helminths and poisonous chemicals.

Effect of Bacteria

The total viable count of bacteria (TVC) expressed as organisms/cm² or as organisms/g on fresh meat or a meat product sets a limit to its shelf-life. Meat will "spoil" with TVC at 10⁶/cm² because of off-odours. Slime and discoloration appear at 10⁸/cm². The main factors determining the time taken for the TVC to reach these levels are the initial count due to contamination during slaughtering and processing, further contamination during storage, temperature, pH and relative humidity. An example of how the level of contamination affects shelf-life is shown in Table 1.

Table 1. Effect of initial contamination on the storage life of lean beef

Initial bacterial count (org./cm ²)	Days at 0°C before slime development
100 000	8
10 000	10
1 000	13
100	15
10	18

After cleanliness, keeping meat products cold is the second most important requirement in order to achieve a desirable shelf-life. Microorganisms rapidly proliferate at elevated temperatures and slime development is a definite visual sign of microbial growth. The importance of temperature in the control of microbial growth is shown in Table 2.

Table 2. Relationship between storage temperature and slime development

Storage temperature (°C)	Days before slime develops
0	10
1	7
3	4
5	3
10	2
16	1

Bacteria relevant to meat, meat products and other food are divided into three groups according to the temperature range within which they can grow: mesophiles 10-45°C, psychrophiles 0-28°C and psychrotrophs 10- 45°C, or slow growth at 0-10°C. Mesophiles will not grow below 10°C but psychrotrophs, of which *Pseudomonas* are the more important, will grow down to 0°C. The nearer to 0°C the storage temperature

the slower the growth of the spoilage bacteria and the longer the shelf-life.

Under ideal conditions bacteria double in number every 20 minutes. A single bacterium multiplies to over one million in less than seven hours:

<i>Time</i>	<i>Number of bacteria</i>
12.00	1
12.20	2
12.40	4
13.00	8
14.00	64
15.00	512
16.00	4 096
17.00	32 768
18.00	262 144
18.40	1 048 576

Some bacteria cause product spoilage, others cause food poisoning. The former limit product shelf-life but the latter cause illness. Almost all foodpoisoning bacteria are mesophiles so refrigeration below 10°C offers good protection. Many mesophiles cause spoilage, but since meat is refrigerated most spoilage is due to psychrophiles. Storing meat at temperatures close to 0°C will inhibit the growth of psychrotrophs. Shelf-life will be extended by avoiding contamination through good hygiene practices.

Aerobic bacteria have an absolute requirement for oxygen which limits their growth to the meat surface. Anaerobic bacteria grow within the meat as they need the absence of oxygen. Facultative anaerobes can grow slowly

within oxygen but grow better in its presence. Food-poisoning bacteria are anaerobes and facultative anaerobes. The most important spoilage bacteria (*Pseudomonas* spp.) are aerobic. Water is required by micro-organisms so reducing the water available below the optimum level will prolong shelf-life.

If meat is stored at a relative humidity (RH) below 95 percent, moisture will be lost from the surface. Since most spoilage bacteria, being aerobic, can grow only on the surface, this surface drying will extend the shelf-life. Moulds (fungi) are able to grow in drier conditions than bacteria so that desiccation has a selective effect on microbial growth. Meat pH is the level of acidity in meat. Stored sugars are broken down to lactic acid. In living muscle it is near 7.0 (above this is alkaline, below is acid). It falls to 5.4-5.6 within 24 hours.

High final-pH values result when animals are exhausted at slaughter, for instance because of fighting in lairage or transport. Spoilage bacteria multiply rapidly on high-pH meat and shorten the shelf-life. Exhausted animals should be rested before slaughter. A high TVC resulting from severe contamination during slaughter or processing will shorten the shelf-life even in ideal conditions. It also indicates poor hygiene so that contamination with food-poisoning bacteria is likely.

Aerobic spoilage by bacteria and yeasts usually results in slime formation, undesirable odours and flavours (taints). Colour changes, rancidity, tallowy or chalky flavours from the breakdown of lipids may also occur. Colour changes as a result of pigment oxidation may be grey, brown or green discoloration. Aerobic spoilage by moulds results in a sticky surface, musty odours, alcohol flavours and creamy, black or green discoloration. Anaerobic spoilage which occurs either within the meat

or on the surface in sealed containers where oxygen is absent or very limited is marked by a souring due to the production of organic acids and gases.

Food Poisoning

Food poisoning may be due to infection or intoxication. Infection is caused by the consumption of live bacteria which multiply in the body producing characteristic symptoms. Intoxication is due to toxins in food produced by bacteria before the food was eaten. Toxins are chemical compounds which may linger in food with no microbes growing in it, and are therefore very dangerous.

Salmonellae are facultative anaerobes which cause infectious food poisoning. Ten or 20 cells of *Salmonella typhi* are sufficient to cause typhoid but 10 000 to 100 000 cells of other species may be necessary to cause an infection. Some are host-specific affecting the animal from which the meat was produced but failing to cause infection when consumed by man. Typical symptoms of salmonellosis include diarrhoea, fever and vomiting. The illness may last one to 14 days after a 12 to 24-hour incubation period. Victims may excrete the bacteria for weeks after the symptoms subside. Poor personal hygiene will cause contamination of meat.

Staphylococcus aureus is a facultative aerobe that causes intoxication. It lives in the nose, throat, hair and skin and on animal hides. Meat is contaminated by handling and by sneezing or coughing. Minute amounts of the toxin will cause illness, which starts within one to eight hours of eating poisoned food. Nausea, vomiting and shock may last for one to two days. On rare occasions it is fatal. This bacterium does not produce off-odours or spoilage so it cannot be easily checked. Refrigeration will control its growth. Cooking may destroy the bacteria but not the

toxin as it is heat stable. It is particularly troublesome in cooked cured meats, normally as a result of recontamination after the curing process in subsequent handling, for instance during slicing.

Clostridium botulinum, an anaerobe, produces the toxin botulin, one of the most poisonous substances known. This attacks the central nervous system causing death by respiratory paralysis. Dormant cells occur everywhere in the soil, fish, animals and plants. High-moisture, low-acid, low-salt conditions at above 3°C favour growth and toxin production. Control measures must destroy spores or prevent growth and toxin formation. Botulism is usually due to undercooking processed meats. Pressure-cooking will give commercial sterility. Pasteurisation (heating to 70°C) and adding salt (NaCl) and sodium nitrite (NaNO₂) is used for canned ham. Refrigeration (0-10°C) is essential for vacuum-packed meats. Frozen storage prevents growth.

Clostridium perfringens, an anaerobic bacterium, is a common cause of food poisoning but is rarely fatal. It grows well in warm meats so is usually found in left-over meats that have not been kept chilled and not been reheated to 70°C to kill the bacteria present. The main symptoms are diarrhoea and weakness which last for 12 to 24 hours after an incubation period of eight to 20 hours.

4

General Hygiene Rules for Meat Industries

When meat-processing operations are carried out within a facility specifically built and maintained for meat processing, sources of contamination can be much more easily and adequately controlled. The following requirements are considered essential to good sanitary preparation of meat and meat products.

Facilities

Floors: Brick, tile, smooth concrete or other impervious, waterproof materials are suitable for floors. In some areas wooden floors will suffice if they are tight, smooth, in good repair and properly maintained. Wooden floors are not suitable in areas where slaughtering or curing takes place and meat juices and moisture collect.

Drains: To carry away waste liquids, there should be sufficient drains of the proper size that are correctly located, trapped and vented. All floors should be sloped toward the drains. Generally for adequate waste disposal, one drain is needed for each 18 m² of floor space in slaughtering areas, and one drain for each 46m² in processing and other areas.

Walls: Glazed tile, smooth cement plaster, rustproof metal panels and smooth plastic panels that are properly caulked are all acceptable for walls in processing and refrigerated areas because they can all be effectively cleaned and sanitised. Other materials are also acceptable if they can be satisfactorily cleaned. In no instance should walls be made of materials that absorb moisture or other liquids. Ceilings must be tight, smooth and free from any scaling that may fall into the meat products, and should also be of moisture-resistant materials. All light bulbs should be covered with unbreakable material to prevent broken pieces from falling into the product.

Doors and doorways: All doorways through which the product must pass, whether suspended on rails or lying on hand trucks, should be wide enough to ensure that the meats never touch the doorways risking contamination. Wooden doors and doorways should be covered with metal with tightly soldered seams.

Water supply: Whether from individually owned and controlled sources such as wells or streams or from a municipal system, the water supply must be potable and abundant cold and hot water must be distributed to all parts of the operation.

Lighting: In all areas where products are critically examined during sanitary control or for cleanliness, 50-foot candles of light should be provided. For adequate visibility 20-foot candles of light should be provided wherever any processing occurs. In all other areas, such as dry storage, there should be sufficient light to keep the area orderly and sanitary.

Refrigeration: The main purpose of refrigeration is to cool the meat down after slaughter and to maintain it in a chilled state for shorter or longer storage periods and

for cutting and further processing. If frozen storage is provided and utilised, it should be maintained at the lowest possible temperature for maximum shelf-life. Minus 18° to -12°C is satisfactory freezer storage; however, large quantities of product must either be quickfrozen prior to storage or thinly spread out to facilitate freezing.

It is also recommended that all rooms where meat is processed, except in the slaughter and cooler storage areas, should be maintained at a temperature of about 12°C. In facilities where no refrigeration or cooling is furnished in processing areas, the handling of meat products is possible if all equipment contacting the products is thoroughly cleaned and sanitised from time to time (recommended every four hours). Frequent cleaning is necessary because in warmer temperatures bacteria multiply rapidly and the risk of product contamination increases.

Meat Processing Equipment

The equipment needed for converting livestock into meat products need not be elaborate and expensive. The amount of equipment will depend on the slaughtering and processing procedures employed. If possible, all equipment should be made of stainless steel or plastic, be rust resistant and easily cleaned and sanitised. All equipment should be constructed of stainless steel, galvanised steel, aluminium or approved plastic. Wooden tables are not acceptable because wood absorbs meat juices and fats and cannot be thoroughly cleaned.

Hardwood cutting-boards maintained smooth and free from checks and cracks may be used. Cutting tables covered with other than hard plastic are not acceptable for contact with meat. All other equipment should be of

the type that can be taken apart and thoroughly cleaned. Any stationary equipment must be located far enough from walls to permit proper cleaning around and under it. In all areas there should be conveniently located foot-pedal or kneeoperated wash-basins with hot and cold water, soap and disposable towels.

In slaughtering areas, lavatories should be convenient to the dressing operations. Hot-water containers, either electric or steam-heated to 82°C, should be available for sanitising tools contaminated with diseased material or other filth during dressing. Rails must be located high enough to prevent meat from touching the floor. For beef carcasses, the minimum height for rails should be 3.4 metres, while 2.4 metres is sufficiently high for small livestock such as goats, hogs and sheep. Rails should also be far enough away from fixed objects and walls to avoid contact.

Personnel Hygiene

Probably as important as anything in the production of clean, wholesome, unspoiled products is the attitude of the workers toward cleanliness. Personnel with clean hands, clothing and good hygienic practices are absolutely essential to the production of high-quality foods. All clothing should be clean, in good repair and made of washable material. Street clothing should be covered with coats or gowns while handling exposed product. White or light-coloured clothing is most desirable and garments that become soiled or contaminated should be changed when necessary.

All persons working with exposed meat products should have their hair under control, either completely covered with a clean cap or hat or confined by a hairnet to prevent hair from falling into products. Safety devices

such as aprons, wrist guards and mesh gloves must be made of impervious material, clean and in good repair. At no time should leather aprons, wrist guards or other devices be worn unless clean, washable coverings are used over them. Light-coloured rubber or plastic gloves may be worn by product handlers only if clean and in good repair.

No person working with meats should wear any kind of jewellery, badges or buttons that may come loose and be accidentally included in the product. Shoes and boots should be worn at all times and should be appropriate for the operations being conducted. They should also be made of impervious materials. Any aprons, knives and footwear that become contaminated during operations should be routinely cleaned in areas or facilities provided for that purpose.

No cloth twine, belts or other similar materials should be used to cover implement handles or used in other places where they may harbour filth and serve as a ready source of product contamination. All unsanitary practices should be avoided by meat handlers. No one should smoke or use tobacco in areas where edible products and ingredients are handled, prepared or stored, or where equipment and utensils are cleaned.

When handling edible products, scratching the head, placing fingers in or around the nose or mouth, sneezing or coughing on the product should never occur. Workers must also guard against contaminating products from localised infections or sores. Workers can contaminate carcasses and meat through handling, coughing and sneezing. This may cause rapid spoilage of the meat or, more seriously, food poisoning. Coughs and sneezes are a particularly effective way of transmitting bacteria to meat.

Transfer of faecal matter either of animal or human origin to the meat is particularly hazardous. Most contamination on the hands of workers in slaughter floors with faecal matter comes from the hides and fleeces. Hands should be washed frequently to remove all visible soiling. Stainless-steel sinks without plugs should be conveniently accessible to all workers. Water should be supplied at approximately 43°C to a simple tap which is foot- or knee-operated.

Liquid disinfectant soap and paper towels should be available. Particular attention should be paid to cleaning under the fingernails. Hands should also be thoroughly washed after using the toilet, smoking, coughing or sneezing, handling money, garbage or soiled or infected material. All precautions should be taken to prevent product contamination by visitors or other persons who are simply passing through the work area.

Cleaning

The floors should be kept clear of all debris, such as hooves and horns, in slaughterhalls or other inedible parts or fat and meat particles in cutting, processing and by-product handling areas, and must be frequently washed down. At the end of each day a thorough cleaning programme should be followed. All matter should be removed from floors, platforms, gullies, etc., followed by a thorough hosing down of walls, floors and all surfaces to loosen dirt. Finally a strong cleaning solution should be applied and left for a while before being rinsed off.

A thorough inspection should be made afterwards and any areas remaining soiled should be cleaned again. In order to maintain the cleanest possible products a standard cleaning routine of the equipment should be

established. Initially all large pieces of refuse material should be scraped or swept together and disposed of. Follow-up should include scrubbing of the equipment using brushes and a soap or detergent and a complete sanitising with hot water at 82°C and an approved chlorine or iodine rinse. Finally, a coating of light mineral oil can be applied to metal equipment, particularly that not fabricated of stainless steel, to prevent rust.

Red Meat Hygiene

The Slaughterhouses Act 1974 applied to England and Wales and consolidated earlier legislation relating to slaughterhouses and knacker's yards. Its purpose was, firstly, to regulate and control the provision of slaughterhouses and knacker's yards and, secondly, to regulate the slaughter of animals. The Act set out the functions of the Minister of Agriculture, Fisheries and Food, local authorities and authorised officers. The Minister had the power to make Regulations for securing humane conditions of slaughter in slaughterhouses and knacker's yards.

Slaughterhouse and meat hygiene were regulated by the Food and Drugs Act 1955, and its successors, the Food Act 1984 and the Food Safety Act 1990. Regulations under the 1974 Act were to be made by Statutory Instrument and were subject to the negative resolution procedure. Before making Regulations, the Minister was required to consult representative organisations likely to be affected. Local authorities were responsible for inspecting premises, licensing slaughterhouses and knacker's yards, making bylaws and, where the duty was not imposed on some other authority, execution and enforcement of the Act and regulations made under it. Enforcement was to

be by authorised officers who were given the right of entry to premises at any reasonable time.

A slaughterhouse was defined as 'a place for slaughtering animals whose flesh is intended for sale for human consumption, and includes any place available in connection therewith for the confinement of animals while awaiting slaughter there or for keeping, or subjecting to any treatment or process, products of the slaughtering of animals there'. A knacker's yard was 'any premises used in connection with the business of slaughtering, flaying, or cutting animals whose flesh is not intended for human consumption'. Both were licensed under the 1974 Act.

Under Part I of the Act, it was an offence for the occupier of any premises to use them, or allow them to be used, as a slaughterhouse or knacker's yard unless he held a licence granted by the local authority. Such a licence lasted for no more than 13 months and, in considering whether it should be granted, the local authority had to decide if it was satisfied that the premises met, or would in a reasonable time meet, food safety regulations and any bylaws applicable to them. However, the local authority could not grant a licence before it received a report on the premises from one of its officers.

Part II of the Act, firstly, prohibited and made it an offence to slaughter an animal other than instantaneously by means of a mechanically-operated instrument or by electricity, rendering the animal insensible to pain until death occurred. The Act also enabled Regulations to be made by the Minister, after consultation with organisations representing affected interests, to prescribe other means of rendering the animal insensible to pain. Exceptions for the Jewish and Muslim faiths were permitted.

Secondly, no animal was permitted to be slaughtered or stunned in a slaughterhouse or knacker's yard except by someone holding a current licence for that purpose. Such licences had to specify the kind of animals which could be slaughtered or stunned and the types of instruments to be used; they were in force for no longer than a year, and could be used in any local authority area. The Minister could make Regulations prescribing qualifications for a licence holder.

Thirdly, this Part of the Act enabled the Minister to make Regulations to secure humane conditions and practices in connection with the slaughter of animals in slaughterhouses and knacker's yards. These Regulations could in particular specify the construction, layout and equipment of such premises and prescribe the conditions to be observed in the confinement and treatment of animals awaiting slaughter and the qualifications of slaughterers holding licences.

In 1986, the granting of slaughterhouse licences was subject to compliance with certain requirements of:

- i. relevant Regulations under the Food and Drugs Act 1955 and its successor, the Food Act 1984, 9 relating to the observance of 'sanitary and cleanly conditions and practices' in connection with the sale of food for human consumption or the importation, preparation, transport, storage, packaging, wrapping, exposure for sale, service or delivery of food intended for sale or sold for human consumption;
- ii. bylaws made by a local authority to secure the sanitary condition and proper management of slaughterhouses and knacker's yards, and the maintenance of records of animals brought into the yard and their disposal; and

- iii. Regulations under section 38 of the Slaughterhouses Act 1974 relating to the construction, layout and equipment of slaughterhouses and knacker's yards and the conditions under which animals were kept and slaughtered.

In deciding whether to grant a licence, the local authority had to decide if the applicant was a fit and proper person, and could refuse to grant a licence, or revoke a current licence, if it decided this was not the case. Similarly, enforcement of this Part of the Act was the duty of the local authority, although the powers of entry to ascertain any contravention of the Act or Regulations could be exercised by either an officer of the Minister or of the local authority for the area in which the premises were situated.

The Act enabled local authorities to make bylaws to ensure that slaughterhouses and knacker's yards were kept in a sanitary condition and were properly managed. Such bylaws had to be confirmed by the Minister. In the case of knacker's yards, the local authority could require the licensee to keep records of animals brought into the yard and of the way in which they were disposed. However, once a slaughterhouse licence was in force, the local authority could not use bylaws to penalise any licensee.

Very few such bylaws were in fact made, and these invariably followed closely the model issued by MAFF and imposed hygiene and record-keeping requirements. The Act enabled local authorities to provide and manage public slaughterhouses, though not public knacker's yards. The bylaw-making powers did not apply to such public slaughterhouses.

After consultation with organisations representing the interests concerned, the Minister could make Regulations to secure humane slaughter conditions and practices. Officers of the Minister, or officers appointed by local authorities, could enter premises to establish whether the Act or any Regulations or bylaws made under it had been contravened.

Food Safety Act 1990

The Food Safety Act 1990 largely maintained and extended the powers contained in the Food Act 1984. It also replaced the Food and Drugs (Scotland) Act 1954, thereby bringing the previously separate arrangements for England and Wales and for Scotland under a single enabling Act.

In 1986, slaughterhouse infrastructure and conditions were regulated by the Slaughterhouse (Hygiene) Regulations 1977, made jointly under the Food and Drugs Act 1955 by the Minister of Agriculture and the Secretary of State for Social Services. Enforcement rested with local authorities. The Regulations required that a slaughterhouse should be constructed so as:

- i. to provide adequate space and facilities for the efficient performance of meat inspection;
- ii. to permit clean operations to be carried out adequately separated from those operations liable to give rise to contamination or pollution; and
- iii. to permit the functioning of all operations under hygienic conditions.

The Regulations imposed upon slaughterhouse operators requirements on construction, layout, drainage, equipment, maintenance, cleanliness, ventilation, lighting, water supply, management and personal hygiene.

Slaughterhouses had to be constructed so as to ensure that those areas in which it was necessary to handle meat for human consumption were entirely separate from those where meat rejected as being unfit for human consumption was handled. Separate areas for handling meat for human consumption considerably reduced the possibility of contamination of fit meat with unfit material.

The 1977 Regulations stated that no person should bring into a slaughterhouse an animal which he knew or suspected to be diseased or injured unless the animal was accompanied by a veterinary certificate. The certificate was required to indicate that the vet was satisfied, after conducting the appropriate enquiries and taking and testing any necessary samples, that the animal was not suffering from any disease or condition likely to render the whole carcass unfit for human consumption, and that the animal had not received any medicament, antibiotic or chemotherapeutic which might do likewise.

The certificate was to be handed to the authorised officer immediately on arrival at the slaughterhouse. Slaughterhouses were also required to ensure that animals known or suspected to be diseased were slaughtered and dressed either at a different time or in a different place from other animals. There was a further prohibition on the bringing into a slaughterhouse of an animal which was not intended for human consumption, and there were restrictions on the admission of carcasses.

First, no person was to bring, or permit to be brought, into the slaughterhouse the carcass of an animal which had died or had been killed and not bled. An exception was made where an animal had died in transit to the slaughterhouse, but in that event the carcass was to be removed from the slaughterhouse immediately following the carrying out of any necessary examination. The result

was that only the carcass of an animal that had been killed and bled could be brought into, and remain, at a slaughterhouse. Even this restriction was subject to certain requirements affecting undressed and dressed carcasses respectively.

An undressed carcass had to be accompanied by a veterinary certificate upon being brought into the slaughterhouse. This certificate had to identify the owner of the carcass, to describe the carcass and any identification marks, to identify the reason for the slaughter of the animal and to contain a statement as follows: It is my opinion, after making due enquiries and taking and testing any necessary samples, that the animal from which this carcass was produced was not affected with any disease or condition liable to render the whole carcass unfit for human consumption and to the best of my knowledge and belief had not received any medicament, antibiotic or chemotherapeutic which might do likewise.

Where a carcass was admitted already dressed, that carcass was required to be accompanied by either:

- i. a certificate certifying that the carcass and its offal had been inspected and passed fit for human consumption; or
- ii. its offal, including the stomach and intestines, and a veterinary certificate in the same terms as that required for an undressed carcass.

In addition, the Fresh Meat Export (Hygiene and Inspection) Regulations 1981 imposed on slaughterhouses exporting meat to other EU states further requirements relating to infrastructure.

Meat hygiene and inspection Regulations provided for the processes of slaughter and cutting of carcasses to

be supervised by authorised officers of the local authority trained for the purpose. The Regulations were directed to:

- i. The identification before slaughter of sick or distressed animals or animals which might be suffering from a disease which would render their meat unfit for human consumption. These measures were intended to prevent so far as possible animals entering the slaughterhouse if it could be seen in advance that their meat would not be fit for human consumption;
- ii. The way in which the animal was slaughtered and its carcass was treated. These measures were designed to minimise the risk of cross-contamination in the slaughterhouse, eg, from faecal matter on the hide of an animal; to facilitate the removal of parts considered unfit for human consumption; and to facilitate postmortem inspection; and
- iii. The postmortem inspection of the carcass in order to determine its fitness in terms of quality and the possible presence of pathogens transmissible to man. The identification of carcasses or parts unfit for human consumption lay at the heart of these Regulations and the treatment of meat determined as unfit was the basis of the human SBO ban, one of the most important measures introduced to protect human health from any risk arising from BSE.

Local authorities were entitled to recoup the full cost of meat inspection from the slaughterhouse operator. The Meat Inspection (Amendment) Regulations 1983 stated that the charges must be based on the actual cost of providing the service at the individual slaughterhouse.

The Fresh Meat (Hygiene and Inspection) Regulations 1995 transferred responsibility for enforcement in slaughterhouses from the local authorities to the Minister. In practice, his responsibilities were discharged by the Meat Hygiene Service (MHS). The MHS was launched as an Executive Agency of MAFF on 1 April 1995, and was responsible from that date for meat inspection, supervision of licensed fresh meat premises and enforcement of the legislation relating to meat hygiene, BSE/SBO controls and animal welfare in these premises.

The Food Act 1984 provided for Regulations to be made governing the hygienic production of meat. Section 13 provided that the Ministers could make whatever Regulations appeared expedient to ensure the sanitary production of meat for human consumption and particularly the staining or sterilisation of meat considered unfit. Section 118 required Ministers to consult organisations representative of interests likely to be substantially affected. The Regulations were enforced by the local authorities responsible for licensing all slaughterhouses as required by the Slaughterhouses Act 1974.

Before the adoption, on 1 January 1993, of the single European standard for meat hygiene, there were two regimes for the control of meat hygiene in slaughterhouses in the UK. Slaughterhouses producing meat that was not intended for export were generally described as 'domestic' slaughterhouses. Meat inspection requirements for these were set out in the Meat Inspection Regulations 1963, made under the Food and Drugs Act 1955 and later the Meat Inspection Regulations 1987 and the Meat Inspection (Amendment) Regulations 1990. The procedures to be followed with meat that was found to be unfit for human consumption were set out in the Meat (Sterilisation and Staining) Regulations 1982.

Slaughterhouses which intended to produce meat for export were described as 'export-approved' slaughterhouses, because they could not do so without specific approval from 'the appropriate Minister' under the Fresh Meat Export (Hygiene and Inspection) Regulations 1981. These also prescribed certain inspection and other requirements. Before giving approval, the Minister had to be satisfied that the premises complied with certain requirements relating to construction, equipment and facilities and to hygiene, ante-mortem health inspection, slaughter and dressing practices, and postmortem health inspection.

He had to notify the relevant local authority and to have regard to any representations that it made, and to arrange for a Veterinary Officer to inspect and report on the premises. If he refused approval, he had to give reasons. No significant alteration to the premises, the equipment or the method of operation could be made without consulting the Minister in advance, and the Minister could revoke approval if was no longer satisfied that the specified requirements were being met.

The procedures to be followed with meat that was found to be unfit for human consumption were set out in the Meat (Sterilisation and Staining) Regulations 1982, and also applied to these slaughterhouses.

Meat Inspection

The Meat Inspection Regulations placed a duty on the local authority to ensure that carcasses were inspected by Authorised Meat Inspectors (AMIs), who were supervised by Environmental Health Officers (EHOs) employed by the relevant local authority. Before 1991, ante-mortem inspection in domestic slaughterhouses was not required in England and Wales, unlike Scotland. No person could

bring into a slaughterhouse an animal which he knew or suspected to be diseased or injured unless the animal was accompanied by a veterinary certificate stating that their condition was not such as to render the whole carcass unfit for human consumption.

The Meat Inspection (Amendment) Regulations 1990 made ante-mortem inspection a requirement in domestic slaughterhouses in England and Wales from 1 January 1991, but defined the authorised inspector specifically to exclude a veterinary inspector. In practice, this would have meant that ante-mortem inspection in domestic plants was carried out by an AMI. By contrast, ante-mortem inspection in domestic slaughterhouses in Scotland was carried out by veterinary inspectors.

The specific provisions of the Meat Inspection Regulations required that each carcass be dressed immediately after slaughter and in such a manner as would not hinder inspection. The requirements as to dressing and inspection of carcasses are set out in detail in a series of schedules to the Regulations. Meat inspection involved postmortem examination of the carcass and offal and either:

- i. passing meat as fit for human consumption and stamping it; or
- ii. detaining it for further examination.

The carcass was stamped with the health mark after the inspector, having inspected it in accordance with the Regulations, was satisfied that the carcass or part of the carcass was fit for human consumption. The health mark consisted of a stamp identifying the inspector who had carried out the inspection. All officers authorised under the Food Act 1984, including the AMI, could reject meat as unfit for human consumption, or seize it if the owner would not voluntarily surrender it.

When meat had been seized, any dispute could be taken before a Justice of the Peace (JP) who could condemn the meat. If the JP decided against condemnation, the local authority would be liable to pay compensation to the owner. In large slaughterhouses, a team of AMIs might be present for most or all of the working day. In very small slaughterhouses, there might be no such continuous presence, but authorised officers would visit the plant to inspect the day's kill. For this purpose, the Meat Inspection Regulations required slaughterhouses to inform the local authority of the times at which slaughter was to take place.

In domestic slaughterhouses, the AMIs were supervised by an EHO who was responsible for checking the hygiene of the premises. The degree of EHO involvement varied, depending on the frequency of their visits to plants. In practice, day-to-day responsibility for hygiene could be delegated to a Senior Meat Inspector or, in small plants, to an AMI. The delegation of hygiene responsibilities had to be authorised by the local authority.

Requirements for export slaughterhouses were set out in the Fresh Meat Export (Hygiene and Inspection) Regulations 1981. Local authorities were responsible for enforcing these Regulations, but the Minister, who had to grant export approval, could suspend or revoke this approval if the plant no longer complied with the Regulations or if a 'significant alteration' had been made without consulting him.

The 1981 Regulations required local authorities to arrange for every animal intended for slaughter in an export slaughterhouse to undergo an ante-mortem health inspection within 24 hours of arrival at the slaughterhouse and of slaughter. Inspections determined

whether animals were showing symptoms of diseases or disorders transmissible through meat to humans or animals, or which would be likely to make the meat unfit for human consumption. Such animals could not be slaughtered for production of meat for human consumption.

If an inspection determined that an animal was injured, fatigued or stressed, the animal had to be rested for an adequate period of time. After such a period of rest the animal was required to be re-inspected before it could be admitted for slaughter. The application of the health mark was made on the same basis as in domestic premises but the mark itself was different. It carried the letters 'UK' and 'EEC' and the approval number of the export premises.

Each export slaughterhouse had to be supervised by an Official Veterinary Surgeon (OVS) appointed by the local authority, who was responsible for all hygiene and meat inspection. OVSs were usually private practitioners employed part-time by the local authority, although a few local authorities had full-time OVSs on their staff. Ministers were responsible for designating individual veterinary surgeons as suitable for OVS work and local authorities could only appoint such designated veterinarians as OVSs.

The AMIs were supervised by the OVS. If a plant was producing meat for the domestic market for some or all of the time, the OVS could attend for as little as one hour a day and delegate much of the responsibility for hygiene in the plant to the EHO. In those plants producing mainly for export, the OVS would be present most of the time to carry out responsibilities for all hygiene and meat inspection in the plant, and had personally to sign the health certificates to accompany export consignments.

The OVSs were 'line-managed' by the local authorities' Chief Environmental Health Officers (CEHOs), but also had responsibilities to the Agriculture Departments which designated them and which had ultimate responsibility for export certification.

The OVS's responsibility generally ended when the meat left the slaughterhouse: if the meat was for export the OVS checked that the lorry was sealed; if it was for the domestic market, it passed into the EHO's sphere of responsibility. However, the OVS was required to provide a 'Health Certificate' to accompany the meat as it was loaded into the means of transport.

The certificate stated the name of the exporting country and the relevant Ministry and Department. It also provided details to assist with the identification of the meat; the address of slaughterhouse of origin and address of the OVS; the destination of the meat and means of transport; and the attestation that the meat came entirely from animals slaughtered in an approved slaughterhouse and that they had been inspected in accordance with the relevant intra-Community Directive.

Ante-mortem Inspection

The principal difference between the requirements for export and domestic slaughterhouses before 1991 was in respect of ante-mortem inspection. However, there were also differences in the Regulations relating to the dressing of the carcass. As already mentioned, the Meat Inspection Regulations 1987 which applied in domestic slaughterhouses required that dressing of the carcass take place immediately after the animal had been slaughtered. Dressing was required to be carried out in such a way as not to prevent or hinder inspection and in particular:

- i. where back bleeding ensued upon the slaughter of an animal the pleura should not be completely detached from the carcass until an inspector authorised their removal;
- ii. no action should be taken which might alter or destroy any evidence of disease, except on the instructions of an inspector;
- iii. the offal, other than the feet of any animal, should after removal from the carcass, be so kept as to remain readily identifiable with the carcass until that carcass had been inspected by an inspector; and the feet of an animal should be kept available for inspection in the slaughterhouse until an inspector authorised their removal;
- iv. Any blood intended for human consumption should be collected and placed in a clean receptacle provided for that purpose and be so kept as to remain readily identifiable with the carcass from which it was collected until these carcasses had been inspected by an inspector.

The Fresh Meat Export (Hygiene and Inspection) Regulations 1981, which applied to export slaughterhouses, included the provisions set out above with the exception of that at (i). The Regulations contained the following additional provisions for dressing bovine carcasses:

- i. the removal was required of the hide or skin, the head (save that where retention of the ears on the carcass was necessary for any certification purpose they need be removed only after completion of that certification), the viscera (save that the kidneys could remain attached on the carcass by their natural connections but were removed from their

- fatty and perirenal coverings), the genital organs, the urinary bladder, the feet up to the carpal and tarsal joints, and, in the case of lactating animals, animals that had given birth or were in advanced pregnancy, the udder;
- ii. evisceration was to be completed not later than half an hour after completion of bleeding; and
 - iii. Bovine animals over 3 months old 15 were to be split lengthways through the spinal column before being submitted for inspection, and an inspector could require the head to be split lengthways if considered necessary in carrying out the inspection.

Postmortem Inspection

In both domestic and export-approved slaughterhouses, postmortem inspection was required to confirm that the carcass was fit for human consumption or to identify any carcass or part thereof which was unfit. In 1986, inspection was governed by the Meat Inspection Regulations 1963. These were re-enacted, with amendments, by the Meat Inspection Regulations 1987. The latter replaced the 1963 instructions for inspecting carcasses, which specified that certain parts of any animal should be examined in certain specified ways, with similarly detailed instructions for each of a number of different species.

The carcass and offal and blood of each animal had to be examined without delay by an authorised officer of the council to determine fitness for human consumption. He was required to have regard to:

- the age and sex of the animal;
- the state of nutrition of the animal;
- any evidence of bruising or haemorrhage;

- any local or general oedema;
- the efficiency of bleeding;
- any swelling, deformity or other abnormality of bones, joints, musculature or umbilicus;
- any abnormality in consistency, colour, odour and, where appropriate, taste;
- the condition of the pleura and peritoneum; and
- any other evidence of abnormality.

The inspection had to include:

- visual examination of the slaughtered animal and the organs belonging to it;
- palpation of certain organs, in particular the lungs, liver, spleen, and tongue and, in the case of mature animals, the uterus and udder;
- incisions of organs and lymph nodes as specified in the detailed instructions relating to postmortem inspection of specific species; and
- any additional incisions or examinations that an inspector considered necessary.

Responsibilities of the Meat and Livestock Commission (MLC)

The MLC was constituted under the Agriculture Act 1967 and charged with 'promoting greater efficiency in the livestock industry and the livestock products industry'. In doing so, it was required to have regard to the interests of consumers as well as to those of the livestock and livestock products industries. The Act empowered the MLC to undertake certain functions in the furtherance of this general duty. These included:

- i. advising slaughterhouse owners and operators on the design and operation of their premises;

- ii. advising on slaughtering and dressing techniques, and advising the Government on slaughterhouse matters;
- iii. promoting or undertaking research into the production, marketing and distribution of livestock and the production, processing, manufacture, marketing and distribution of livestock products; and
- iv. promoting or undertaking arrangements for advertising the merits, and increasing the sales of livestock and livestock products produced in Great Britain.

The involvement of the MLC's staff within slaughterhouses was limited. The Agriculture Act gave it no inspection powers or functions, except where delegated by the Minister or where invited in by slaughterhouse operators. The MLC told the Inquiry that what in 1989 had been called its Fatstock Service staff had certified carcasses in slaughterhouses as agents of, and under instruction from, the Intervention Board in respect of subsidy schemes.

It believed that this had involved 50 per cent of beef cattle slaughtered each year. In addition, its staff provided an independent meat classification system to slaughterhouse operators on a fee-paying basis. The certification work for the Intervention Board took place only at certain slaughterhouses certified by the Board, with the role of the MLC's staff limited to that of ensuring that the dressing standards of the market support scheme were met. This included observing whether spinal cord had been removed. However, spinal cord removal was not at the core of the various classification standards, which concentrated on weight and the dressing of the carcass.

The independent meat classification system provided by the MLC operated in the abattoir after the postmortem inspection and the operating rules did not require feedback on any aspect of the treatment of SBO. Feedback was confined to matters associated with grading or dressing specifications. In addition to this work within slaughterhouses, the MLC provided advice and training to slaughterhouse operators and staff. It offered a general service advising and offering training on slaughterhouse organisation and design.

The service did not focus on BSE-related issues (its function was abattoir design and layout, not process control) and, in any event, was discontinued in 1993 due to falling demand. Organisations providing training for slaughterhouse staff also received MLC support, although the task of ensuring that such staff were properly trained remained the responsibility of individual slaughterhouses. During 1990 and 1991, and again from late 1995 to mid-1998, the MLC investigated methods of removing spinal cord from carcasses safely and effectively.

In 1990, at the behest of supermarkets, it attempted to develop a suction device to remove spinal cord. However, this work was abandoned in August 1991 when it became obvious that the work was not technically feasible. In 1995 the MLC began to investigate other methods and got so far as developing a twin blade saw to remove the spinal cord while still encased in the spinal column. This development, however, was overtaken by the discovery of infectivity in the dorsal root ganglia in late 1997.

Sterilisation of Unfit Meat

Under the Meat (Sterilisation) Regulations 1969, a number of restrictions were imposed upon the way in which

knacker meat and meat unfit for human consumption could be dealt with. In each case 'meat' was defined to include offal and fat and any product of which a principal ingredient was meat. Subject to certain exceptions, these restrictions applied so long as the 'meat' in question had not been sterilised.

'Sterilised' was defined as meaning treated by boiling or by steam under pressure until every piece of meat was cooked throughout or dry-rendered, digested or solvent-processed into technical tallow, greases, glues, feeding meals or fertilisers. Enforcement powers (described below) were given to authorised officers of local authorities. 'Local authority' was defined under the Food and Drugs Act 1955 as meaning, for any borough and any urban district or rural district, the council of the borough or district.

'Authorised officer' was defined (also under the Act) as meaning an officer of the council authorised by them in writing, either generally or specially, to act in matters of any specified kind or in any specified matter, and - for the purpose of taking samples - included a police constable authorised by the police authority concerned. In order to be authorised to act in relation to the examination and seizure of meat an officer was required to be one of the following:

- i. a medical officer of health;
- ii. a sanitary inspector;
- iii. a member of the Royal College of Veterinary Surgeons (RCVS) employed for the purpose of inspection of food; or
- iv. a person having such qualifications as might be prescribed by Regulations made by the Ministers.

The medical officer of health and the sanitary inspector of a council were to be deemed authorised officers by virtue of their appointments. A member of the RCVS employed for the purpose of inspecting food was to be deemed authorised for the examination and seizure of meat under the provisions of Part I of the Act relating to food unfit for human consumption. As regards the restrictions imposed by the 1969 Regulations, first, the occupier of a slaughterhouse was prohibited from causing or permitting to be removed from the slaughterhouse, and any person was prohibited from removing from a slaughterhouse, any meat which was unfit for human consumption, unless that meat had first been sterilised.

Second, the occupier of a knacker's yard was prohibited from causing or permitting to be removed from the knacker's yard, and any person was prohibited from removing from a knacker's yard, any meat, unless that meat had first been sterilised. Each of these prohibitions was subject to exceptions for removal:

- i. to any hospital, medical or veterinary school or similar institution for instructional or diagnostic purposes or to any manufacturing chemist for the manufacture by him of pharmaceutical products; or
- ii. subject to certain requirements, to any processor for sterilisation by him, or to any zoological garden, menagerie, mink farm, or trout farm, or to any person by arrangement in writing with an authorised officer for preparation before further removal to any processor or manufacturing chemist or for storage.

The requirements for exception (ii) were that in each case the meat was removed in a vehicle or impervious container, which was kept closed and locked at all times except when necessary for the loading or unloading of

the contents or their examination by an authorised officer. The vehicle or container was also required to bear a notice of adequate size which was conspicuously visible and contained a distinct, legible and unambiguous statement to the effect that the meat was not for human consumption.

Third, it was an offence for any person to possess for the purpose of sale or preparation for sale butcher's meat which was unfit for human consumption, or knacker meat, unless that meat had first been sterilised. 'Butcher's meat' was defined as meaning meat from any animal slaughtered in the UK for sale for human consumption. 'Knacker meat' was defined as meaning meat from any animal slaughtered in, or carcass brought into, a knacker's yard in the UK. The Regulations provided for two defences to proceedings for contravention of this prohibition. It was a defence for an individual to prove:

- i. that he did not know and could not with reasonable diligence have ascertained, that the meat was unfit for human consumption or was knacker meat: or
- ii. that he had made arrangements for it to be sterilised without any unnecessary delay.

There was exempted from this prohibition any meat:

- in any slaughterhouse or knacker's yard;
- subject to certain requirements, 19 in the possession of any person while in transit from a slaughterhouse or knacker's yard to:
 - i. any processor;
 - ii. any zoological garden, menagerie, mink farm or trout farm;
 - iii. any person by arrangement in writing with an authorised officer for preparation before

- removal to any processor or manufacturing chemist;
- in the possession of any person while in transit from a slaughterhouse or knacker's yard to any hospital, medical or veterinary school or similar institution for instructional or diagnostic purposes or to any manufacturing chemist for the manufacture by him of pharmaceutical products;
 - on the premises:
 - i. of any processor for sterilisation by him;
 - ii. of any manufacturing chemist for the manufacture by him on those premises of pharmaceutical products;
 - iii. of any zoological garden, menagerie, mink farm or trout farm;
 - iv. subject to certain requirements, 20 of any person by arrangement in writing with an authorised officer for preparation before removal to any processor or manufacturing chemist or for storage on those premises; or
 - in transit to the premises of any processor or manufacturing chemist in a vehicle or container in accordance with (iv) above.

These first three prohibitions were subject to an exemption where there were no facilities for sterilisation in a slaughterhouse or knacker's yard. In that event those prohibitions did not apply to any meat removed from that slaughterhouse or knacker's yard by arrangement in writing with an authorised officer to a place where it would be sterilised or destroyed.

Fourth, no person was permitted to sell, or offer or expose for sale, by retail, any butcher's meat which was

unfit for human consumption, or knacker meat, unless that meat had first been sterilised. It was a defence to proceedings for contravention of this prohibition for an individual to prove that he did not know, and could not with reasonable diligence have ascertained, that the meat was unfit for human consumption or was knacker meat.

The 1969 Regulations required any person responsible for the consignment or delivery of any butcher's meat which was unfit for human consumption, or knacker meat, in any of the circumstances covered by the Regulations, to give or send with the meat a notice to the person by whom or on whose behalf the meat was to be received. That notice was to contain information relating to the meat, including: particulars of the date of its consignment or delivery; its quantity and description; and the name and address of the person responsible for its consignment or delivery, and of the person by whom or on whose behalf it was to be received.

The person responsible for the consignment was required to retain a copy of the notice and the person by whom or on whose behalf the consignment was received was required to retain the original. In each case, the notice was to be retained for three months after the date of the consignment and be produced for inspection to an authorising officer upon request.

An authorised officer had, at all reasonable times, a power to examine any meat not intended for human consumption which had been sold, was offered or exposed for sale or was in the possession of, or had been deposited with or consigned to, any person for the purpose of sale or preparation for sale. The authorised officer had a further power to seize the meat and remove it in order for it to be dealt with by a Justice of the Peace (JP), if it appeared to the officer that the meat was required:

- i. to be sterilised, but it had not been sterilised; or
- ii. to bear a notice, but it did not bear a notice.

Having seized any meat under this power, the officer was required to inform the person in whose possession the meat was found of his intention to have it dealt with by a JP. Anyone liable for prosecution under the terms of the Regulations was entitled, if he attended before a JP, to be heard and to call witnesses. If the JP considered that the meat brought before him, whether seized under the provisions of this Regulation or not, was meat to which the Regulations applied and was required to be but had not been dealt with in accordance with the Regulations, he was required to condemn it and order it to be destroyed or to be so dealt with. If the JP refused to condemn the meat, the council was required to compensate the owner of the meat for any depreciation in its value resulting from its seizure and removal.

The Regulations also provided that if an authorised officer had reason to suspect that any vehicle or container contained any meat to which the Regulations applied and which was intended for sale or was in the course of delivery after sale, then he had a power to examine the contents, and, if necessary, detain the vehicle or container (subject to exceptions in the case of certain vehicles). If he found any meat which was required to be but was not dealt with in accordance with the Regulations, the authorised officer was able to seize the meat and remove it.

Meat (Sterilisation and Staining) Regulations 1982

The principal changes brought into effect by the introduction of the Meat (Sterilisation and Staining) Regulations 1982 were:

- i. staining was reintroduced as an alternative to sterilisation;
- ii. different measures were required for different categories of meat and offal; and
- iii. a new system of movement permits intended to assist in tracking unfit meat was introduced.

The Meat (Sterilisation and Staining) Regulations 1982 revoked the Meat (Sterilisation) Regulations 1969. They applied to particular categories of 'meat' (including 'offal'), and required, unless certain exceptions applied, that the meat or offal in question be:

- i. sterilised;
- ii. subject to restrictions on removal, before sterilisation;
- iii. not sold, before sterilisation; and
- iv. subject to restrictions on storage and freezing, before sterilisation.

Sterilisation

'Sterilisation' was defined as being:

- i. treated by boiling or by steaming under pressure until every piece of meat was cooked throughout;
- ii. dry-rendered, digested, or solvent-processed into technical tallow, greases, glues, feeding meals or fertilisers; or
- iii. subjected to another process which resulted in all parts of the meat no longer having the appearance of raw meat and which inactivated all vegetative forms of human pathogenic organisms in the meat.

Staining

The 1982 Regulations defined 'stained' to mean treated

with a solution of the colouring agent Black PN or Brilliant Black BN. The solution was to be of such a strength that the colouring on the stained meat was clearly visible. The definition added that for this purpose 'treated' meant that all pieces of meat not smaller than primal cuts had been opened by multiple and deep incisions, and that the whole surface of the meat had been covered with a solution as aforesaid either by immersing the meat in, or spraying or otherwise applying, the solution.

Both carcass meat at a slaughterhouse found to be unfit for human consumption and specified offal at a slaughterhouse had to be:

- i. sterilised immediately; or
- ii. placed immediately in a room or receptacle designed for the purpose of holding meat awaiting sterilisation and bearing a notice stating that its contents were to be sterilised on the premises, and then to be sterilised at the slaughterhouse.

There were two exemptions from this requirement in the case of carcass meat or specified offal which:

- i. was stained by the occupier of the slaughterhouse immediately after it was brought into separate accommodation dedicated to the retention of unfit meat; or
- ii. was intended to be removed from the slaughterhouse under the authority of a movement permit issued pursuant to the Regulations to a destination referred to in 17(1)(a).

Regulation 7 provided that, any offal other than specified offal at a slaughterhouse found to be unfit for human consumption was required:

- i. to be sterilised immediately; or
- ii. to be placed immediately in a room or receptacle designed for the purpose of holding meat awaiting sterilisation and bearing a notice stating that its contents were to be sterilised on the premises, and then to be sterilised at the slaughterhouse.

The Regulations imposed a prohibition upon any person removing or causing or permitting to be removed from any slaughterhouse of which he was the occupier, any meat unfit for human consumption unless that meat:

- i. had been sterilised;
- ii. being carcass meat or specified offal, had been stained, and was intended and authorised by a movement permit to be delivered to a destination referred to in Regulation 17(1)(b) to (e);
- iii. being carcass meat or specified offal, was intended and authorised by a movement permit to be delivered to a destination referred to in Regulation 17(1)(a);
- iv. being offal other than specified offal, was intended and authorised by a movement permit to be delivered to a destination referred to in Regulation 17(1).

A person was exempted from the requirement to obtain a movement permit for the removal from a slaughterhouse occupied by him of:

- i. any green offal intended to be delivered to the premises of a processor for sterilisation; or
- ii. any carcass meat or offal other than green offal if such meat was removed in a container the contents of which consisted mainly of green offal and which was intended to be delivered to the premises of a processor for sterilisation.

It was a defence for any person charged with a contravention of, or a failure to comply with, Regulations 6,7 or 8 to prove that he did not know, and could not with reasonable diligence have ascertained, that the meat was unfit for human consumption.

Sterilisation in Knacker's Yards

Carcass meat and specified offal derived from an animal slaughtered in, or brought into, a knacker's yard was required to be sterilised immediately after skinning, evisceration, or cutting up (whichever operation was the last carried out at the yard). There were three exemptions from this requirement in the case of carcass meat or specified offal which:

- i. was placed immediately after skinning, evisceration, or cutting up (whichever operation was the last carried out at the yard), in a room or receptacle designed for the purpose of holding meat awaiting sterilisation and bearing a notice stating that its contents were to be sterilised on the premises, and then to be sterilised at the yard; or
- ii. was stained at the knacker's yard immediately after skinning, evisceration, or cutting up (whichever operation was the last carried out at the yard); or
- iii. was intended to be removed from the knacker's yard under the authority of a movement permit to a destination referred to in Regulation 17(1)(a).

Any offal other than specified offal derived from an animal slaughtered in, or brought into, a knacker's yard was required immediately after evisceration:

- i. to be sterilised; or
- ii. to be placed immediately in a room or receptacle designed for the purpose of holding meat awaiting

sterilisation and bearing a notice stating that its contents were to be sterilised on the premises, and then to be sterilised at the yard.

For present purposes, there were two exemptions from this requirement:

- i. in the case of offal other than specified offal (including any green offal not intended to be removed in accordance with the exception at (ii) below), which was intended to be removed from the knacker's yard under the authority of a movement permit issued pursuant to the Regulations to a destination referred to in Regulation 17(1);
- ii. any green offal, and any other offal not being specified offal which was in a container the contents of which consisted mainly of green offal, which in either case was intended to be removed from the knacker's yard to the premises of a processor for sterilisation.

The Regulations imposed a prohibition upon any person removing or causing or permitting to be removed from any knacker's yard of which he was the occupier, any meat unless that meat:

- i. had been sterilised;
- ii. being carcass meat or specified offal, had been stained, and was intended and authorised by a movement permit to be delivered to a destination referred to in Regulation 17(1)(b) to (e);
- iii. being carcass meat or specified offal, and was intended and authorised by a movement permit to be delivered to a destination referred to in Regulation 17(1)(a);

- iv. being offal other than specified offal, was intended and authorised by a movement permit to be delivered to a destination referred to in Regulation 17(1).

A person was exempted from the requirement to obtain a movement permit for the removal from a knacker's yard occupied by him:

- i. of any green offal intended to be delivered to the premises of a processor for sterilisation; or
- ii. of any carcass meat or offal other than green offal if such meat was removed in a container the contents of which consisted mainly of green offal and which was intended to be delivered to the premises of a processor for sterilisation.

The Regulations imposed a prohibition upon any person removing or causing or permitting to be removed from any place of which he was the occupier, not being a slaughterhouse or knacker's yard, any meat unfit for human consumption cut from any variety of cattle, sheep, pig, equine animal or goat which had died or been slaughtered at that place or had been brought there having died or been slaughtered, unless that meat:

- i. had been sterilised;
- ii. being carcass meat or specified offal, had been stained, and was intended and authorised by a movement permit to be delivered to a destination referred to in Regulation 17(1)(b) to (e);
- iii. being carcass meat or specified offal, was intended and authorised by a movement permit to be delivered to a destination referred to in Regulation 17(1)(a);
- iv. being offal other than specified offal, and was intended and authorised by a movement permit to

be delivered to a destination referred to in Regulation 17(1);

- v. was intended to be delivered to a knacker's yard.

Freezing of Meat

The Regulations imposed a prohibition on any person freezing any carcass meat which was unfit for human consumption or specified offal in a slaughterhouse or any carcass meat or specified offal in a knacker's yard unless that meat had been sterilised or stained. There were two exemptions from this prohibition:

- i. in the case of any meat which was intended to be removed under the authority of a movement permit, from the slaughterhouse or knacker's yard to a destination referred to in Regulation 17(1)(a); and
- ii. in the case of any meat from a carcass infested with *Cysticercus bovis* which was frozen in accordance with relevant meat inspection provisions.

Possession for Sale

The Regulations prohibited any person from possessing for the purpose of sale or preparation for sale:

- i. any meat removed from a slaughterhouse, which was unfit for human consumption;
- ii. any meat removed from a knacker's yard; or
- iii. any meat unfit for human consumption from an animal which had died or had been slaughtered at a place other than a slaughterhouse or knacker's yard, or had been brought to such a place after having died or been slaughtered; unless that meat had been sterilised.

There were exemptions from this prohibition in the case of any meat which was in the possession of a person:

- i. while in transit under the authority of a movement permit to a destination referred to in Regulation 17(1)(a); and
- ii. referred to in Regulation 17(1)(e) at his premises; and, where required by the Regulations, had been stained;
- iii. while in transit under the authority of a movement permit to a destination referred to in Regulation 17(1)(b) to (e); and, where required by the Regulations, had been stained;
- iv. at premises listed in Regulation 17(1)(a) to (d) for any purpose contemplated in the provisions or with a view to its removal from those premises in accordance for the provisions relating to closure, breakdown or trade dispute or while in transit from such premises in accordance with those provisions..

It was a defence for any person charged with a contravention of this provision to prove:

- i. that he did not know, and could not with reasonable diligence have ascertained, that the meat was unfit for human consumption or removed from a knacker's yard; or
- ii. that any meat removed from a slaughterhouse became unfit only after its removal.

The Regulations imposed a prohibition on any person selling or offering or exposing for sale, by retail, any meat which was unfit for human consumption, or any knacker meat, unless that meat had been sterilised. For the purposes of this prohibition, a sale by retail did not include a sale of meat direct from a slaughterhouse or

knacker's yard to a destination referred to in Regulation 17(1).

It was a defence for any person charged with a contravention of this provision to prove that he did not know, and could not with reasonable diligence have ascertained, that the meat was meat to which this prohibition applied.

Meat Storage

No person was permitted to store any unsterilised meat which was unfit, or not intended, for human consumption:

- i. in the same room as any meat which was fit for human consumption, unless that meat was stored according to an arrangement which ensured that it was adequately separated from the meat which was fit for human consumption and that the arrangement had been approved by the appropriate local authority; and
- ii. unless any container, wrapper, or other packaging used to hold the meat bore a notice of adequate size which was conspicuously visible and contained a distinct, legible and unambiguous statement to the effect that the meat held therein was not for human consumption, together with the name of the packer and the address at which the meat was packed.

Meat unfit for human consumption and knacker meat could be removed unsterilised and unstained from a slaughterhouse or knacker's yard which was not equipped for the sterilisation of meat provided that:

- i. all the destinations referred to in Regulation 17(1) and to which it was reasonably practicable to deliver that meat were, by reason of permanent or

- temporary closure of the premises or breakdown of machinery or a trade dispute, unable to receive the meat;
- ii. the meat was transported in a vehicle or impervious container which was locked or sealed at all times and which bore a notice of adequate size which was conspicuously visible and contained a distinct, legible and unambiguous statement that the meat contained therein was not for human consumption; and
 - iii. the meat was removed in accordance with an arrangement in writing with, and under the supervision of, an authorised officer of the local authority in whose district the slaughterhouse or knacker's yard was situated, to a place where it was buried or destroyed.

Further, carcass meat unfit for human consumption, or specified offal and knacker meat consisting of carcass meat or specified offal, could be removed unsterilised and unstained from a slaughterhouse or knacker's yard which had exhausted, and could not practicably replenish, its supplies of staining fluid, to a destination referred to in Regulation 17(1)(b) to (d). This could be done if that meat was delivered in accordance with an arrangement in writing with, and supervised by, an authorised officer of the local authority. The removal of any meat in accordance with these provisions exempted the occupier of the slaughterhouse or knacker's yard from any requirement imposed by the Regulations to sterilise or stain the meat.

Destinations and Mode of Transport

The 1982 Regulations imposed requirements on

destinations and mode of transport, limiting what could be done at such destinations, and imposing (with exceptions) a scheme of movement permits.

Meat unfit, or not intended, for human consumption, or knacker meat, could be removed, in accordance with any movement permit required by the Regulations to be issued in respect of that movement, to one of the destinations identified in Regulation 17(1).

Meat removed to a destination referred to in Regulation 17(1)(b) to (e) was required to be removed in a vehicle or impervious container which:

- i. was kept closed and locked or sealed at all times except when necessary for the loading or unloading of the contents or their examination by an authorised officer; and
- ii. bore a notice of adequate size which was conspicuously visible and contained a distinct legible and unambiguous statement to the effect that the meat carried therein was not for human consumption.

Once meat unfit, or not intended, for human consumption, or knacker meat, had reached any of the premises referred to in Regulation 17(1)(a) to (e) it could not be further removed from those premises unless that meat:

- i. had been sterilised; or
- ii. was removed from the premises referred to in Regulation 17(1)(e), and was intended to be delivered to another destination listed in Regulation 17(1)(a) to (e) and its removal to that destination was authorised by a movement permit issued pursuant to the Regulations; or

- iii. could not be disposed of at those premises by reason of permanent or temporary closure of the premises or breakdown of machinery or a trade dispute, and was removed in accordance with an arrangement in writing with, and under the supervision of, an authorised officer of the local authority in whose district those premises were situated, to another destination referred to in Regulation 17(1)(a) to (d) or a place where it was buried or destroyed.

Regulation 19 set out the procedure to be followed in those cases where the Regulations required removal of meat from certain premises to take place under the authority of a movement permit. At least two working days before the day on which the unsterilised meat was to be removed from such premises, the occupier of the premises or owner of the meat had to apply to the local authority, giving the following information:

- i. the intended removal date;
- ii. the description of the meat;
- iii. the address and description of the premises to which the meat was to be delivered; and
- iv. the expected date of arrival of the meat at those premises.

Upon receipt of an application the local authority was required, without undue delay, to satisfy itself that the premises to which it was intended to deliver the unsterilised meat were of a kind referred to in Regulation 17(1) and were capable of processing or otherwise disposing of the meat. If the premises were situated in the district of another local authority, the authority to whom the application was made was required to notify that other authority that the application had been made, and

was required to take into account any information obtained from that authority in reaching its decision on the nature of the premises.

When the occupier of any premises, or the owner of any meat, to which the Regulation applied, regularly delivered unsterilised meat of a specific description to a particular destination, the authority in whose district the premises or meat were situated was required - on receiving an application stating the description of that meat and the address and description of its destination - to authorise in advance each such movement by issuing whatever quantity of movement permits it considered appropriate.

Movement permits were to be in the form specified in the schedule to the Regulations. The permit was divided into Parts I to V. When satisfied of the matters referred to in Regulation 19(2), a local authority was required to complete Part I of the permit and issue to the applicant an original and three copies of the permit.

The occupier of the premises from which the unsterilised meat was removed under the authority of a movement permit was required to complete Part II of the document delivered to him and to give the original and two copies to the driver of the vehicle by which the meat was removed and to keep the other copy for two years.

When the driver delivered the meat to the premises named in the movement permit, he was required to give that permit to the occupier of those premises. The occupier was then required to complete Part III of the permit and to acknowledge receipt of the meat thus delivered to him by signing the original and two copies and was required, within seven days of receiving the meat, to send the original and one copy to the local authority in whose district his premises were situated.

The occupier was required to retain the other copy for two years from the date on which he received that meat.

If the driver was unable to deliver the meat to the premises named in the movement permit, he was required without delay to inform or cause to be informed either the local authority which had issued the permit, or the local authority in whose area the delivery premises were situated. That authority was required without delay to authorise the delivery of the meat to another destination referred to in Regulation 17(1), or, if no such alternative destination was available, require the meat to be returned to the premises from which it had been removed, or to be buried or destroyed under its supervision.

The driver was required to hand the movement permit to the occupier of the premises to which the meat was delivered, or, in the case of its burial or destruction, to the supervising authority. The occupier of the premises to which the meat was delivered was required to complete Part IV of the movement permit, acknowledge receipt of the meat to which the permit related by signing the original and its two copies and, within seven days of the receipt of the meat, to send the original and one copy to the local authority in whose district his premises were situated. The occupier was required to retain the other copy for two years from the date on which he received the meat to which it related.

Any local authority which was sent a movement permit was required to complete Part V of that permit and to send the original to the authority which had issued it and retain the copy for two years. Any person required to retain a document under Regulation 19 was required to make that document available for inspection by an authorised officer at any reasonable time.

Meat (Sterilisation and Staining) (Amendment) Regulations 1984

The 1982 Regulations were amended by the Meat (Sterilisation and Staining) (Amendment) Regulations 1984. The definition of 'specified offal' was amended to mean the hearts, kidneys, livers and lungs derived from an animal which, in the case of a carcass in a slaughterhouse, had been rejected by an authorised person as unfit for human consumption by reason of any disease or pathological condition other than:

- i. ascariasis, fascioliasis, or telangiectasis; or
- ii. changes caused by the operations of stunning, slaughter or dressing of the animal.

A Regulation was introduced disapplying the 1982 Regulations in respect of meat removed or intended to be removed from any place or premises by, or under the authority of, a veterinary surgeon for examination by him or on his behalf. A further prohibition was introduced against any person bringing, or causing or permitting to be brought, into England and Wales from Scotland or Northern Ireland any meat unfit for human consumption.

The exemptions from this prohibition were identical to those which existed in relation to the removal of unfit meat from a slaughterhouse, save for the fact that importation of meat from Scotland and Northern Ireland required the meat to be accompanied to the destination by a consignment note or permit rather than a movement permit. The driver of the vehicle in which the meat was delivered to any premises, accompanied by a consignment note or a permit, was required to give that note or copy of that permit to the occupier of those premises.

The occupier was required to retain that document for two years and within seven days to send a copy to the

local authority in whose area his premises were located. The document was required to be available for inspection by an authorised officer at any reasonable time. Upon receipt of the copy, the local authority was required forthwith to notify in writing of the arrival of the consignment:

- i. in the case of an importation from Scotland, the local authority from whose district the meat was imported;
- ii. in the case of an importation from Northern Ireland, the Department of Agriculture Northern Ireland.

This prohibition resulted in consequential amendments to the range of persons authorised to declare 'specified offal' as unfit and to the prohibition on possession for sale, the exemptions from that prohibition and the defences to it in Regulation 20 of the 1982 Regulations.

Regulation 7 of the 1984 Regulations amended the list of destinations to which unfit meat could be delivered under the authority of a movement permit. The first destination was amended to include a 'pharmaceutical extract supplier' - ie, a person whose business consisted, wholly or mainly, of the collection, storage, and preparation of glands, liquid extracts and other materials derived from the carcasses of animals, prior to their removal to a manufacturing chemist for the manufacture of pharmaceutical products.

The third destination was amended to prohibit the removal to a zoo, menagerie, fur farm, maggot farm, or greyhound kennels of carcass meat or offal rejected by an authorised person as unfit for human consumption by reason of tuberculosis. The fifth destination was amended so as to make removal or storage prior to further removal

permissible only where the subsequent removal was to a processor; further removal to a 'manufacturing chemist' was no longer permitted.

Finally, subsequent removal, under Regulation 17(3) of the 1982 Regulations, from any of the listed destinations was now to be permitted in circumstances where the meat was removed from a hospital, medical or veterinary school, laboratory or similar institution in accordance with an arrangement in writing with, and under the supervision of, an authorised officer of the local authority in whose district the premises were situated to another destination listed in Regulation 17(1)(a) to (d) or to a place where it was buried or destroyed.

6

Meat Products

Every operator must provide adequate facilities for the collection of inedible meat products. The registration of blueprints for plant facilities is for both edible and inedible areas of the registered establishment. All blueprints for registered establishments, including those for facilities, required for the collection, storage and disposal of inedible meat products must be registered by the Chief, Plants and Equipment of the Meat and Poultry Products Division.

A registered establishment should be designed in such a way that, starting from the slaughter of food animals, inedible waste products and inedible meat products are progressively removed from the carcass. As the carcass is being dressed, heavily contaminated portions such as hair, hide, feathers, etc. are being removed and the carcass is moved to progressively cleaner areas. As they are being separated from the carcass, the inedible products shall be moved to the inedible section of the plant. There shall be no direction reversal of inedible meat products. Unless otherwise indicated separate receiving, separate shipping, freezer, and cooler if necessary must be provided for inedible meat products.

Sanitary conditions must be maintained at all times throughout the inedible section of the establishment. A daily clean up shall be carried out and immediate effective action shall be taken if unsanitary conditions develop. An effective insect and rodent control program shall be maintained in the inedible section of the registered establishment. This program should be similar to the program in effect in the edible section of the establishment.

Plant employees working exclusively in the inedible section of the establishment shall have welfare facilities separate from employees working in the edible section of the registered establishment. If it is absolutely necessary that an employee working in the inedible section of the plant carries out work in the edible section, then that employee shall be required to completely change his protective clothing and thoroughly wash his hands before he commences work in the edible section of the establishment. Within the inedible section of the establishment, the raw material handling area shall be separate from the section where the sterilised inedible material is handled.

Proper segregation must be maintained between the different categories of inedible meat products. When adequate segregation is not maintained between condemned meat products that require to be sterilised and other inedible meat products, all inedible meat products must be treated as condemned meat products requiring sterilisation. Adequate facilities to render or denature the inedible meat product as applicable must be provided.

The shipping containers for meat products destined for animal food or for medicinal purposes shall be labelled in accordance with subsection 94(2) of the Meat

Inspection Regulations, 1990. The establishment ventilation shall be such that the air flow is, under no circumstance, directed from the inedible to the edible section. An effective system of odour control shall be provided in the inedible section of the registered establishment.

Due to the high price of protein material, the destruction of condemned meat product by incineration is no longer of great importance. Operators wishing to incinerate condemned meat products may do so, on condition that the operator provides incineration facilities approved by the local authorities and by the Meat and Poultry Products Division. Registered establishments that receive inedible oils, fats, bones or meat scraps shipped directly from a retail store, restaurant or public institution, as provided for in subsection 44(2) of the Meat Inspection Regulations, 1990 shall provide receiving facilities directly to the inedible section of the establishment premises.

Receipt of such products through edible receiving areas is not acceptable. The receipt of dead animals for rendering in a registered establishment (other than those dying en route to a registered establishment) is only permitted with special permission from the Director, Meat and Poultry Products Division, under section 45 of the Meat Inspection Regulations, 1990. Such permission is only given when such receipt does not create any unsanitary condition on the establishment premises and when such a disposal is in the public interest.

Dry or wet rendering methods may be employed. The destruction of viable pathogens is important in breaking the chain of infection. The heating process shall destroy all salmonella present in the raw material. It is also important that no recontamination of the sterilised

rendered product takes place. All reasonable precautions must be taken to prevent reintroduction of salmonella and other pathogens through insects, rodents, birds and other animals. Inedible tallow and other inedible fats may be shipped appropriately identified for industrial use.

Separate storage tanks, pumps and pipelines shall be used for the handling of inedible fats. Shipping areas for sterilised inedible meat products shall not be used for the receipt of raw materials for rendering. They shall be well protected to prevent recontamination. Sterilised and bagged inedible meat products shall be appropriately marked when shipped from the registered establishment.

Separation of Inedible Meat Products

Condemned Products

Of all the inedible meat products in a registered establishment, condemned meat products require the closest supervision. The reason for this is obvious. Condemned meat products could be accidentally or fraudulently added to meat products approved for human consumption. Some condemned meat products could also spread disease to man and animals if they are not handled and disposed of in a sanitary manner. It is the operator's responsibility to dispose of condemned meat products as prescribed in section 54 of the Meat Inspection Regulations, 1990.

Inspectors are responsible to ensure that the operator is carrying out his responsibility. Condemned meat products include carcasses and portions of carcasses which upon inspection or reinspection are found to be affected by disease or an abnormal condition that renders them unfit for human food. It further includes animals condemned on antemortem inspection, carcasses of

animals that died enroute to the registered slaughter establishment and carcasses of animals that died in the yard or a livestock holding pen of the registered slaughter establishment.

Wherever applicable, a separate room or area shall be provided for the skinning of condemned carcasses and their preparation for rendering. Under no circumstance shall the skinning, evisceration and other preparation of animals condemned on antemortem inspection, or found dead carcasses, be allowed on the killing floor. Such condemned food animals or found dead carcasses shall be directly conveyed from the livestock yards or pens to the inedible section of the registered slaughter establishment.

The collection and conveyance of condemned carcasses, organs and portions of carcasses or any other condemned meat product from the killing floor and processing area shall be done in a sanitary manner. Any contact of condemned meat products with carcasses being dressed or approved meat products shall be prevented. All equipment having been in contact with condemned meat products shall be cleaned and sanitised as required before reuse. Plant personnel and inspectors handling condemned meat products shall wash their hands and clean and sanitise their work clothing and equipment as required.

Containers used for condemned meat products shall be distinctly marked "Condemned" and containers used for animal food products shall be marked "Animal Food". They should be preferably of a colour that distinguishes them from containers used for edible meat products. In addition to sanitary considerations, it is essential that condemned material be maintained under rigid inspectional control until disposed as per section 54 of the Meat Inspection Regulations, 1990.

Condemned meat products require sterilisation. The control measures will include one or several of the following:

- product is mixed with intestines or an accepted denaturing agent and crushed or ground in a continuous and non reversible mechanical conveying system which empties directly to a melter or a conveyance acceptable to the inspector in charge for transportation to another registered establishment or authorised inedible rendering plant for sterilisation;
- product is freely slashed, crushed or ground and mixed or sprayed with an accepted denaturant. The denaturant shall be reasonable well distributed to ensure that all condemned meat products are denatured. Product is shipped in containers marked with the words “Condemned” to another registered establishment or an authorised inedible rendering plant for sterilisation;
- In the case of a carcass that has not been dressed, the denaturant may be applied by injecting it into portions of the carcass to the extent necessary to preclude its use for human or animal food purposes.
- Canned meat products may be disposed of by crushing and burying, provided such disposal receives prior approval from the Regional Director, Meat Hygiene.

Operators may harvest or salvage certain condemned meat products for animal food with the consent of an official veterinarian. These products may be intended for fish, pets, zoo animals and fur animals. Condemned meat products may be used for animal food provided:

- i) they are derived from carcasses, portions or organs that are not affected with a disease transmittable to the above mentioned animals.
- ii) they are derived from carcasses, portions or organs that are not affected with a disease that is a potential cause of zoonoses for handlers of this material;
- iii) they are derived from carcasses, portions or organs where lesions or conditions mentioned in (ii) and (iii) are removed.

In the case of partial condemnation, i.e. condemnation of portions or organs, such consultation is not necessary provided the condemned meat products have been trimmed to make them free of transmittable pathogens. Operators wishing to engage in the harvesting or salvaging of meat products for animal food must provide adequate facilities for the separation, chilling, packing, marking, storage and denaturing of the product. Denaturing is required to clearly distinguish such meat products from those prepared and approved for human consumption.

In order to be considered as being properly denatured, charcoal or another accepted denaturing agent will have to be added to the meat product. Meat products shall be cut into pieces small enough to carry out effective denaturing. The denaturing shall be carried out in the inedible products area of the establishment. In the case of poultry carcasses, poultry intestines may be ground up with carcasses instead of charcoal or other accepted denaturing agents.

With the consent of an official veterinarian, operators may harvest or salvage certain condemned meat products for medicinal purposes. In situations where a specific

need is identified to use such products for medicinal purposes, a request shall be made to the Chief Epidemiology, Agri-Food Safety Division. The request shall include all the pertinent information (meat products to be salvaged, proposed use, salvaging process, etc.).

In the case of meat products that are judged by an official veterinarian to be unacceptable for rendering due to dangerous residues or for other reasons, may be disposed of in accordance with local environmental requirements.

Condemned meat products derived from a food animal affected with a reportable disease shall be destroyed pursuant to subsection 48(1) Health of Animal Act.

Non Condemned Products

Operators wishing to engage in the harvesting or salvaging of meat products for animal food must provide adequate facilities for the separation, chilling, packing and marking, storage and denaturing of the product, as required. Denaturing is required to clearly distinguish such organs and portions approved for animal food from those prepared and approved for human consumption. The denaturing shall be carried out in the inedible products area of the establishment.

Organs or portions shall be denatured with charcoal or another agent accepted by the Agri-Food Safety Division for that purpose. An exception to the use of an approved denaturant may be made in the case of spleens, lungs, udders, uncleaned gastro-intestinal tracts and poultry heads and feet. Animal food livers which are directly delivered from a registered establishment to a fish hatchery operated by the federal or by a provincial government may be shipped without being denatured.

Animal food products derived from non-condemned meat products in containers, fully marked, may be frozen and stored in a freezer used for freezing and storage of packaged, fully marked meat products for human consumption. Such meat products for animal food may also be shipped from the edible shipping area. The freezing, storage and shipment of these fully packaged and marked animal foods shall only be allowed if they are kept apart from meat products approved for human consumption and provided such handling does not create any lowering of the standards of sanitation.

Animal food products may be received from other registered establishments for freezing, storage and shipping in the frozen state provided they are packaged, identified for use as animal food, and their handling does not pose any sanitary problems. All handling of inedible products harvested or salvaged for animal food shall be carried out away from edible product and as much as physically and operationally possible in a section of the establishment used only for that purpose.

Operators may harvest or salvage inedible meat products for medicinal purposes on their premises. Operators wishing to engage in the harvesting or salvaging of such meat products must provide adequate facilities for the separation, chilling, packing, marking and storage of the product. Inedible meat products destined for medicinal purposes in containers, fully marked, may be frozen and stored in a freezer used for freezing and storage of packaged, fully marked meat products for human consumption. Such meat products may also be shipped from the edible shipping area.

The freezing, storage and shipment of these fully packaged and marked for medicinal purposes shall only be allowed if they are kept apart from meat products

approved for human consumption and provided such handling does not create any lowering of the standards of sanitation.

Guidelines for the collection of bovine fetal blood for pharmaceutical or research purposes. The collection of bovine fetal blood for the above usage is permitted in registered establishments where the process and handling are carried out in a manner which does not interfere with plant sanitation or unnecessarily create potential infection to employees. Adequate protection is to be provided to employees by management. All proposals are to be forwarded to the Chief, Plants and Equipment, with detailed plans, through the regional office to ensure that facilities are satisfactory to carry out the operations in a satisfactory manner. The following requirements shall be met:

- The feti are to be derived from carcasses in accordance with client specifications, but must exclude those derived from animals which reacted to the official test for Brucellosis. This is to reduce the health risk in regard to human contacts, during handling.
- Uteri containing the feti must be conveyed intact to a suitable room or area in the inedible section of the establishment. The access area to and from the collection room should avoid backtracking and preclude cross-contamination. As an example, when a container is used, it must be water tight and properly identified.
- The collection room or area must have accepted room surface materials, satisfactory drainage and lighting. A rust-resistant metal table with drainage is required for bleeding with an adjacent knife sanitiser. A suitable handwashing station is to be

provided along with soap, towels and disinfectant solution for personal hygiene. A hot and cold water outlet is required for room clean-up.

Inedible meat products that are treated by the operator as condemned meat products. The collection and disposal of all inedible meat products in this category shall be carried out in a sanitary manner. Although inspectional control over this type of inedible meat product is not as critical as it is in the case of other condemned products, an orderly handling is still important. Such products can be a source of contamination if handled improperly.

This type of inedible meat product should be conveyed via the shortest possible route to the appropriate section of the inedible products area of the registered establishment to be disposed of in keeping with section 54 of the Meat Inspection Regulations, 1990. An appropriate disposal effort should be made by plant management to prevent unnecessary accumulation of such products anywhere in the edible section of the establishment.

Products which are by their nature not edible: The collection and disposal of inedible products in this category shall be carried out in a sanitary manner. These products shall be taken forthwith to the appropriate section of inedible products area in a manner that prevents contamination of any edible meat product.

Disposal of Inedible Meat Products

Manure, paunch and viscera contents shall be disposed of in a manner which will not create a sanitary problem on the premises of the registered slaughter establishment. Storage of such wastes in the vicinity of the registered is not acceptable.

Conditions under which Condemned Meat Products to be Sterilised may be Shipped from a Registered Establishment

- a) *Facilities for shipment:* General construction requirements for registered establishments apply also for condemned meat product holding rooms and shipping areas. Hot and cold water for clean-up purposes and for handwash facilities must be available.
- b) *Frequency of shipment:* Generally, it is understood that a daily pick-up service of condemned meat products is provided. Special permission for less frequent pick-up service may be given by the Regional Director, Meat Hygiene if refrigeration is provided in the room where the condemned meat products are stored.
- c) *Containers for shipment:* Bulk containers or barrels used for shipment of denatured condemned meat products, from one registered establishment to another registered establishment or to an authorised inedible rendering plant, shall be impervious, in good repair, and shall be returned in a clean condition. They shall be marked with the word "Condemned".
- d) *Sanitation:* A daily clean-up of the condemned product holding room shall be carried out. In addition, whenever unsanitary conditions develop due to a spill of product or for any other reason, management shall arrange for an immediate clean-up.

Conditions under which Condemned and other Inedible Meat Products may be Received in a Registered Establishment for Sterilisation

- a) *Facilities:* A separate receiving area for the inedible

meat products must be set aside in the inedible section of the registered establishment. Structural facilities of the inedible section of the receiving registered establishment shall be such that the receipt of these additional inedible meat products originating in another registered establishment can be carried out.

- b) *Receipt of dead animals:* The receipt, handling and disposal of dead animals other than those dead on arrival or those that died on the establishment premises requires special permission from the Director of the Meat and Poultry Products Division, as per section 45 of the Meat Inspection Regulations, 1990. Such permission is only given under extenuating circumstances.
- c) *Sanitary requirements:* The receiving area for condemned and other inedible meat products must be separate from any area where edible meat products are prepared, stored, shipped or received. The receipt of the above described inedible meat products shall not interfere with sanitary standards in the registered establishment. Sanitary facilities for the cleaning and sanitising of containers and vehicles transporting inedible meat products must be available. Containers and vehicles returned to the other registered establishments must be clean and sanitary.

Authorisation Procedures

Requests for authorisation of inedible rendering plants shall be made to the Regional Director, Meat Hygiene. Premises meeting requirements are listed as plants authorised to receive condemned meat products for sterilisation. Authorised inedible rendering plants are not

registered under the Meat Inspection Act and are therefore not considered registered establishments. After receipt of a request for authorisation of an existing plant the following steps are followed:

- a) The Regional Director requests a complete initial survey of the premises of the rendering plant to determine the acceptability of the layout of the premises.
- b) A copy of the inspecting officer's report is forwarded to the management of the rendering plant. This report should describe construction details, equipment layout and operation of the existing plant. The report should further outline the improvements and changes required for authorisation of the premises.
- c) If management decides to make the required improvements then it shall submit three copies of the building blueprints and equipment layout, together with three copies of the plot plan. The blueprints shall be accompanied by specifications of construction of floors, walls and ceilings, details of drainage, water supply, welfare facilities, and all other relevant information. If the Regional Director is satisfied with the proposed changes, then he should forward the blueprints and relevant information together with his recommendation to the Chief, Plants and Equipment of the Meat and Poultry Products Division for evaluation and approval.
- d) After review of the plans and completion of the renovations, the Regional Director, Meat Hygiene of the Region in which the inedible rendering plant is located will arrange for a final plant inspection. If

renovations have been carried out satisfactorily, the Regional Director will recommend authorisation of the inedible rendering plant to the Director of the Meat and Poultry Products Division.

- e) In all instances, inedible rendering plants must comply with all federal provincial and municipal requirements before authorisation is given by the Director of the Meat and Poultry Products Division.

Structural, equipment and operational requirements

- a) An authorised inedible rendering plant shall be of solid construction, with interior finishes of smooth, hard and impervious materials capable of being cleaned.
- b) The flow of product shall be such as to preclude any backtracking or intermingling of raw and cooked product.
- c) The receiving dock area shall be hard surfaced, shall have suitable drainage and shall lead directly to the cooker charging area.
- d) The cooker discharge, percolator, press, grinders and other equipment in the finished product area shall be entirely separate from the charging and other raw material handling areas.
- e) Each melter and cooker shall be provided with an automatic temperature-recording device.
- f) The shipping area for sterilised product shall be separate and apart from any raw product receiving area.
- g) All floors shall be of concrete, tile or other approved construction, adequately sloped and drained.

- h) Adequate facilities for the washing and sanitising of vehicles and containers shall be provided. Containers and vehicles returned shall be clean.
- i) Satisfactory employees welfare facilities shall be provided. Such facilities shall include washrooms, showers, toilets, cloakrooms and lunchrooms if employees consume food on the plant premises. The facilities shall be adequately ventilated, provided with potable water and artificial light.
- j) Management is responsible for providing employees with protective clothing and having it laundered regularly. Employees shall frequently change their protective clothing.
- k) Plant premises shall have adequate ventilation and be equipped with condensers to control odours.
- l) An adequate program of insect and rodent control shall be carried out on the plant premises.
- m) Any sterilised product not shipped in bulk containers shall be appropriately identified.
- n) Hide storage room shall be separate and apart from the processing section of the plant.
- o) A good janitor service shall be maintained throughout the plant and processing areas shall be regularly cleaned and sanitised. It is essential that a supply of cold and hot water be available.
- p) Suitable disposal facilities for paunch contents shall be available.
- q) Management shall be responsible for the provision of watertight bulk containers or other containers for the pick-up of condemned and other inedible meat products. Leaking containers presented for pick-up of condemned and other inedible meat products in

registered establishments shall be rejected by inspectors. Inspectors shall have unlimited access to the plant premises and shall have access to a telephone (for local or collect calls), washroom, toilet, and shall have permission to use a desk to write reports, as required. A filing cabinet or drawer which can be provided with a departmental lock shall be reserved for the use of the inspector.

- r) Management shall keep records of condemned meat products received for sterilisation from registered establishments. Those records shall be available for the inspector's review, as required.

Preparation of products at the authorised inedible rendering plant

- a) Inedible protein residue such as meat meal, bone meal, blood meal, feather meal, etc.
- b) Inedible tallow and other inedible fats.
- c) Animal hides and skins.
- d) Animal food.

It should be noted that the Meat and Poultry Products Division does permit the salvage of animal food from dead animals and other inedible meat products in authorised inedible rendering plants, provided such salvage is allowed under provincial legislation. Such salvage, however, should be carried out in separate rooms acceptable for that purpose. Under no circumstance shall it be permitted that any animal food products be salvaged from condemned, denatured carcasses or portions to be sterilised shipped from a registered establishment. These meat products shall be rendered sterile. Animal food salvaged in an authorised outside inedible rendering plant shall be denatured and labelled in the same manner as in registered establishments.

Meat Cutting and Utilisation

Throughout the world, countries have varied natural resources and capabilities for producing livestock and different methods must be used to utilise all meat products correctly and completely whether they are cut from cattle, goats, sheep, swine, deer or other animals and whether they come from the tender or less tender parts of those animals. In order to get the maximum eating satisfaction and also the maximum nutritional value, each cut must be matched with the correct cooking procedure. Loin cuts which are generally tender should be prepared by broiling or other dry-heat methods while cuts with considerable bone and connective tissue from the shanks should be either braised or simmered for stews and soups.

Generally, meat animals should be maintained in an environment that permits optimum growth and development. Animals gaining weight rapidly are usually in good condition and the meat derived from their carcasses will be fatter, juicier and richer in flavour. Additionally, the amount of meat in proportion to hide, bone and offal will be greater. The age to slaughter animals varies depending on many things. The highest

quality beef comes from animals that are under 36 months of age. Old cows produce highly acceptable beef if properly fattened and processed.

Depending on the calf and the feeding regime, calves are best slaughtered between three and 16 weeks of age. Hogs may be killed any time after they reach six weeks of age, but for the most profitable pork production may need to be fed for five to ten months. Sheep and goats may be killed anytime after six weeks, but the more desirable age is from six to 12 months.

All meat animal carcasses are composed of muscle, fat, bone and connective tissue. The chief edible and nutritive portion is the muscle or lean meat. The muscle is seldom consumed without some of the attached fat and connective tissue. The carcass composition of animals slaughtered after usual fattening periods is shown in Table 3. It can be noted that the carcass composition varies little between species and is some what dependent on the fatness of the animal at slaughter.

Table 1. Comparative differences in various compositional aspects of marketweight beef, pork and lamb

	<i>Beef</i>	<i>Pork</i>	<i>Lamb</i>
Average live animal weight (kg)	454-544	95-104	45
Age (months)	36	6	8-12
Dressing percentage	60	70	50
Carcass weight (kg)	272-318	68-73	23
Carcass composition (%)			
Lean	52	50	55
Fat	32	32	28
Bone	16	18	17

The lean of each meat animal carcass consists of about 300 individual and different muscles of which only about

25 can be separated out and utilised as single muscle or muscle combinations. The separated muscles are not all the same. They vary widely in palatability (tenderness, juiciness, flavour) depending on the maturity or age of the animal and the body location from which they were taken.

Generally, muscles of locomotion found in the extremities or legs are less tender and more flavourful than muscles that simply support the animal such as those found along the back. The latter are usually more tender and less flavourful. Other factors may influence palatability but maturity and body location are probably the most important. Colours of the lean and fat are important characteristics of a normal, wholesome products. Most diseased or unnatural conditions will change the colour from what is considered normal for the species.

Generally the colour of the fat will be from pure white to a creamy yellow for all animals. Pink or reddish fat probably means that the animal had a fever or was extremely excited prior to slaughter. The colour of the muscle tissues for normal product should be:

<i>Meat</i>	<i>Colour</i>
Beef	Bright cherry red
Goat meat	Light pink to red
Lamb	Light pink to red
Pork	Greyish pink
Veal	Light pink to red
Venison	Dark red

Almost always tissues from older animals are darker in colour. At times the fat on some carcasses from young animals will be dark yellow because of the breed which

lacks the ability to convert yellow carotene to colourless vitamin A and/or because the animals have consumed large amounts of green forage. It is not uncommon for aged ruminant animals to have carcasses with yellow fat. At times animals will suffer from stress prior to slaughter and signs of their reaction will be evident in the carcass.

Stressed cattle often produce dark cutters in which the muscle is not the normal bright cherry red but rather is dark red and sticky. Hogs suffering from porcine stress syndrome (PSS) prior to slaughter may yield carcasses that are pale, soft and exudative (PSE) or dark, firm and dry (DFD). Exudative carcasses are watery and rapidly lose water. None of these conditions produced by ante-mortem stress renders the product inedible but both lower the palatability and eye appeal of the beef and pork and can be confused with other more serious disease conditions.

Meat-cutting Equipments

- solid cutting table, preferably made of non-corrosive material (stainless steel, aluminium or galvanised material) with hard plastic top. If wood has to be used instead of plastic only tight wooden tops/cutters should be used.
- oil or water sharpening stone
- sharpening steel
- knives
- boning - 20 cm straight
- steak - 30 cm curved
- meat saw - hand or electric
- totes, bins and meat trucks (plastic or other non-corrosive material)

- wrapping table
- paper or plastic foil/bags for meat wrapping
- tool holder
- metal mask/safety gloves
- boning aprons/safety aprons
- hand wash-basin
- knife steriliser

Beef Cutting

Four essential points when cutting beef (or any other meat animal carcass) are:

- Cut across the grain of meat when possible.
- Use sharp knives and saws for speed and good workmanship.
- Keep the cutting table orderly and have a place for everything.
- Be clean and sanitary in all operations.

There are different ways to cut the fore- and hindquarters of beef depending on its use, the wishes of the consumers, and the quality of the carcass. (Fig. 1) Poor-quality meat is normally used for further processing, while higher-quality and thicker-fleshed carcasses are used as fresh meat in the form of steaks and roasts.

Halving

Halving is done immediately after the animal has been dressed and every effort should be made to saw the carcass into equal sides through the centre of the backbone.

Quartering

Quartering or ribbing down is the division of a side of beef between the twelfth and thirteenth ribs into fore-and hindquarters. One rib is usually left on the hindquarter to hold the shape of the loin and to make it easier to cut steaks. Dividing between the twelfth and thirteenth ribs splits the carcass almost in quarters, usually with slightly heavier forequarters. Make this cut straight and neat. Locate the exact place between the ribs on the inside of the carcass and make the cut about 5 cm from the midline at the flank.

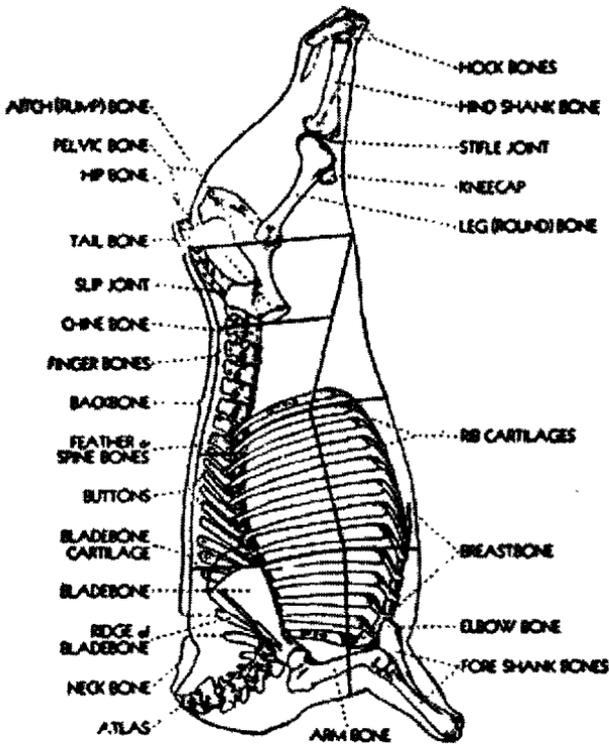


Figure 1. The beef carcass and its bones

The flank part should be left attached until the quarter is ready to be carried to the cutting table. Then saw the backbone, making the cut even with the incision that was made with the knife to produce a smooth and attractive appearance to the small end of the loin. Make this cut from the inside. The large muscle exposed when this cut is made is the "eye of beef" in which most of the quality characteristics of the meat can be seen including colour, marbling, firmness and texture. High-quality beef will have a bright cherry-red colour, some intramuscular fat or marbling, be firm to the touch and fine in texture.

When the person carrying the meat has a firm grip on the forequarter, the small strip of flesh holding the quarters together should be cut. With some practice and experience, one can learn to carry a forequarter easily by holding below the shank so that the full weight of the quarter is on the carrier's shoulder when it is cut down. By taking a step forward as the cut is being made, it is easier to have the quarter drop with the right proportion of weight on the shoulder. The right forequarter should be carried on the left shoulder and the left forequarter on the right shoulder. When placing the forequarter on the cutting table, always have the inside up.

Bone-in method

By far the easiest way to merchandise meat is to have some basic information relative to the bone and muscle structure of the carcass and to utilise an electric saw to cut up the whole carcass. This is now being done to a large extent by meat packers who cut out what is commonly referred to as a wholesale or primal cut such as a whole chuck (shoulder), rib, loin or round of beef. The cut may or may not be trimmed of some bone and fat and then vacuum-packaged and shipped to a retail store.

The vacuum-packaging provides an anaerobic atmosphere and the refrigerated shelf-life of the product may be extended as much as two or three months. The store personnel need have only the slightest knowledge of meat cutting. The primal is positioned correctly and run across the saw in a prescribed fashion, the saw dust is scraped off, and the consumer-sized cut packaged for retail sale. Common wholesale or primal cuts of beef from the forequarter are the square-cut chuck, shank, brisket, plate and rib, and from the hindquarter the flank, loin and round. The kidney knob consisting of kidney and fat is removed from the loin. Since the hindquarter contains a higher proportion of tender cuts, it is usually in greater demand and returns higher prices.

Forequarter: The first cut to make is between the fifth and sixth ribs counting from the neck back. This cut is made parallel with the ribs and produces a cross-cut chuck consisting of a square-cut chuck (also called chuck and blade), foreshank and brisket. Next the foreshank and brisket are removed by cutting through the first sternal cartilage (the first soft segment of the breastbone), and making the cut almost parallel with the backbone of the carcass.

Foreshank: The foreshank is separated from the brisket by following the natural connective tissue seam between the muscles with a knife. The foreshank can then be sawn into small pieces to be used for soup stock or the lean may be removed and used for ground meat.

Brisket: The brisket, boned and made into a roll, can be used either as a pot roast or can be cured (corned).

Square-cut chuck: This wholesale cut contains the first five ribs of the forequarter and may be sawn into steaks or roasts. Several cuts are usually made across the bottom or shank end of the chuck resulting in arm steaks or

roasts. The chuck is then turned and cuts are made parallel with the ribs, resulting in blade steaks and roasts. If the carcass is of high quality and thickly fleshed, steaks cut from the rib end of the chuck or across the arm bone will be highly desirable. Blade cuts to be used as roasts should contain two or three ribs and should be trimmed as for standing rib roasts, although for convenience in carving all bones may be removed. The portions nearest the neck usually have more connective tissue and are recommended for simmering rather than for steaks and roasts.

Only the neck remains to be processed. It is usually severed at a point where it enlarges to meet the shoulder. The neck contains a large amount of bone and connective tissue and is generally used for simmering, corning or grinding. All bloody portions should be trimmed off before other cutting is done.

Short plate: The cut to divide the short plate from the rib is made 18–25 cm from the inside edge of and parallel with the chine or backbone. This division varies according to the thickness of the carcass. With a thick carcass, the cut may be made further down the ribs, and with a thin carcass nearer the spinal column. The plate may be used for different purposes, but it is commonly used for stews or further processing. Short ribs, which are suited for broiling, are also cut from the upper portion of the plate, usually about 5–8 cm in length.

If the plate is to be used for corning, all of the ribs should be removed. If used for stews, the ribs can be left in and the plate sawn crosswise into small pieces. The plate can also be boned and the meat used for ground meat or sausage products. Before cutting the plate in any way, remove the tough membrane lining the inner portion below where the ribs join the breastbone.

Rib: The rib cut is made up of the rear seven ribs in the forequarter. This is the most valuable piece of meat from the forequarter because it is the most tender and has the least amount of bone. It has a large bundle of muscle fibre that runs parallel to the backbone. There are several different ways to prepare the rib cut for cooking as a roast. It may also be used for steaks. It may be prepared as a bone-in, folded or rolled roast. If prepared as a bone-in roast, the superior spinous processes of the vertebrae or featherbones are loosened from the meat and then cut off with a saw.

In making this cut, keep the knife as close to the bone as possible to avoid removing the thin lining that surrounds the bundle of muscle fibre next to the bone. With the saw, cut across the ribs at intervals of about 8 cm, just deep enough to cut through the ribs. Also remove the yellow connective tissue or ligament found between the outer covering and the layer of muscle. The only difference between bone-in and a folded rib roast is that a small 5-cm piece of rib is removed so that the thin end of the cut may be folded and skewered to the heavy portion. This simply makes a neater, more compact package.

Hindquarter: Place the hindquarter on the cutting table with the inside of the carcass up because the first cut made is to remove the kidney knob from the inside of the loin.

Kidney knob: Begin removing the kidney fat at the lower end and loosen it with a knife where it is attached to the loin, leaving a thin covering on the inside of the loin and being careful not to cut into the tenderloin muscle.

Flank: Remove the flank next by cutting into the scrotum or udder, following the round muscle and

cutting close enough so little of the lean meat is taken from in front of the stifle joint. Continue cutting along and below the outer portion of the line of the kidney fat, or in a straight line to leave 10 cm of the thirteenth rib in the flank. This cut may vary with the thickness of the carcass and is lowest in thick or heavy carcasses.

The tough membrane covering the inside of the flank must be removed by cutting off a thin strip on the lower side and then peeling off the membrane. A small piece of lean meat on the inside of the end portion of the flank, weighing 1.2-1.4 kg, is known as the flank steak. This heavy bundle of muscle fibres is dry and if used for steak is often scored on both sides, marinated or sliced thin to make it more tender and desirable as a steak. The entire defatted flank may be used for stew or ground beef or rolled around stuffing and pot-roasted.

Round: The round and loin are divided at about the fourth sacral joint in the spinal column to almost parallel with the back end of the round, or to about 5 cm in front of the stifle joint. The aim is to cut the tip of the ball-and-socket bone in the hip joint, cutting off a piece about 2.5 cm in diameter. The round includes the rump, round cushion (consisting of knuckle piece and inside round muscle or topside), outside round muscle (also called bottom round muscle or silverside) and hind shank.

Remove the rump by cutting just below the exposed pelvic or aitchbone. The rump usually has a large amount of bone. The most desirable piece of rump is cut from the upper portion and is composed of eye and bottom round muscles. The removal of bone and tying the rump means that it requires less oven space and is easier to carve. Round steak is cut in comparatively thin slices from the full round after removal of the rump. The choicest round steaks are cut from the centre section.

The remaining portion is made up of the hind shank and the piece called the heel of the round. The heel of round is used as a pot roast and is removed by cutting close to the bone and tearing away as much meat as possible from the backside. The shank can be sawn into pieces to be used for soup stock.

Loin: The loin is usually completely sawn into steaks beginning at the large end. Sirloin steaks are cut first and the first three or four are known as wedge or round bone sirloin steaks. These are the least desirable pieces of the sirloin. The last sirloin is cut where the hip-bone is separated from the spinal column and the steak cut there is known as the hip-or pin-bone sirloin steak.

The small portion of the loin known as the short loin is the source of T-bone steaks. This area contains the two most tender muscles in the whole carcass, namely, the loin eye muscle above the bone and the tenderloin muscle below the bone. T-bone steaks are cut to about 10 cm from the end of the short loin. This tip portion can either be used as a roast or be cut into rib steaks. Rib steak from the short loin is identified by the piece of the thirteenth rib remaining on it.

When beef is to be cured and dried, pieces should be taken from either the chuck or the round. If the round is used, remove the rump and follow the procedure for muscle boning. If taken from the chuck, use the heavy muscle lying over the outside of the shoulder-blade commonly known as shoulder clod.

Muscle-boning method

One excellent approach to the cutting up of meat animal carcasses which is becoming more popular and utilised by large meat processors is the procedure commonly referred to as "muscle-boning". While this procedure is

particularly adaptable to large carcasses such as beef, it can be successfully used on carcasses or cuts of any size. Muscle-boning is also popular among hunters who do not have meat saws but who want to cut up a whole carcass with a knife while removing the bone that would otherwise fill valuable freezer space. Any animal carcass with a complete and thick layer of subcutaneous or cover fat would have to have most of the fat removed in order to expose the muscles.

Once the fat is removed, a boning knife can be used to separate each large individual muscle or group of muscles. This is done along the seams of connective tissue that encases each muscle. Once separated the muscle mass is then cut from the bone, thus the term "muscle-boning". The advantages of this procedure are numerous; however, the principal reasons for using it are to obtain small-sized portions for sale or preparation; to permit each muscle or muscle combination to be treated or prepared according to its individual characteristics of size, tenderness, flavour or fibre orientation; and to remove much of the bone and fat that would otherwise take up packaging and storage space.

Directions for muscle-boning a side of beef are given here. Initially for muscle-boning, the side of beef is divided into fore-and hindquarters as described for the bone-in method. Also, both the fore-and hindquarters are placed on the cutting table with the inside up. One muscle-boning method is as follows:

Forequarter: The forequarter is sawn into square-cut chuck, foreshank, brisket, rib and plate as in the bone-in method.

Foreshank: The foreshank has attached to it, behind the elbow joint, a relatively large, thick piece of muscle. This is usually cut out by following the connective tissue

seams and produces a fairly large triangular-shaped cut correctly identified as boneless arm roast. The remainder of the foreshank can be sawn into soup bones or can be separated into bone and soft tissue with a knife. The soft tissue is composed of muscle, fat and a large amount of connective tissue which is best utilised as ground meat.

Brisket: The ribs and sternum are lifted from the inside of the brisket and the excess fat is removed. The brisket can either be rolled and tied to be used as a pot roast or it can be cured.

Square-cut chuck: The neck is sawn from the chuck and trimmed of bone, fat and the large prescapular lymph gland. The boneless neck can be utilised as a pot roast; however, it is more often cut into cubes for stew or ground meat.

From the large remaining portion of the chuck, the ribs and feather bones (superior spinous processes) are removed with a knife and the heavy, yellow connective tissue or elastin is removed from the top of the cut. With a knife the thick portion is then separated into outside and inside portions by following the inside or smooth side of the blade-bone which is then lifted from the outside piece along with what remains of the arm bone. The inside portion which contains some of the rib eye muscle is often rolled and tied to be used as a pot roast. There is a part of the outside chuck, a muscle that somewhat resembles the tenderloin muscle in size and shape but not in tenderness, which is often cut into steaks known as chuck fillets.

Rib: The rib is prepared by first sawing across the rib bones to facilitate the removal of both the backbone and the ribs with the knife. Another procedure often used to bone out a rib is carefully with a sharp knife to loosen the small strip of meat found between the ribs. The ribs are

then loosened by cutting close to the bone and removed by striking with a blunt instrument. After removing all bones and the heavy yellow connective tissue, the meat may be rolled into a tight bundle with the thin portion on the outside and tied tightly. Preparing ribs in this way makes for convenient carving and requires less cooking and storage space. About 25 percent of the initial rib weight is lost when the bones are removed. The boneless rib may also be sliced into boneless rib steaks.

Plate: After the heavy connective tissue lining is peeled from the inside of the plate, the bones are removed and the lean meat cubed for stew or prepared for grinding in a way similar to the trimming of the brisket.

Hindquarter: As a first step, the kidney and accompanying fat are removed from the hindquarter carefully with a knife so as not to cut into the tenderloin muscle. The hindquarter is then separated into flank, round and loin as described in the bone-in method.

Flank: Remove the flank by cutting into the scrotum or udder, following the round muscle and cutting close enough so that little lean meat is taken from the front of the stifle joint. Continue cutting along and below the outer portion of the line of the kidney fat in a straight line and saw through the thirteenth rib. Again the flank steak is removed as described in the bone-in method.

Round: The round and loin are separated with a saw as described in the bone-in method. The pelvic bone is removed from the round and the muscle sections of the round are exposed.

Muscle-boning the round means that the large muscle masses of the round are separated from each other by following the natural connective tissue seams. In front of

the stifle joint, the tip or knuckle piece is removed, then the topside or inside round muscle, and then the remaining silverside or bottom round muscles. The latter is often divided and the eye of the round removed separately. All of the separated muscles may then be used as roasts or sliced into steaks. Muscle-boning is particularly useful when beef is prepared for roasting for large groups such as pit barbecuing.

Hind shank: The hind shank, somewhat like the foreshank, has a large muscle group attached to it that can be removed and utilised as a pot roast. This cut is sometimes referred to as the "duck" of beef.

Loin: The tenderloin muscle is carefully cut from the inside of the loin and usually cut into individual steaks. The remainder of the loin is then sawn just in front of the hip-bone into the short loin and sirloin sections. The bone is removed from the sirloin which is a somewhat complicated procedure because the pelvic bone is fused with the backbone. The short loin is boned and the muscle that is known as boneless top loin is usually cut into boneless top loin steaks.

On-the-rail Boning

This is a modification of the muscle-boning method. Typical for on-the-rail boning is the hanging position of the hindquarter or the entire beef side during the boning procedure. The removal of the different meat cuts from the hanging carcass is considerably facilitated. Beef cuts can easily be pulled downwards under their own weight after cutting them free along their natural connective tissue seams. Special hooks with handles used by the operators are an additional aid for the correct fixation of the cuts during boning.

On-the-rail boning is the most hygienic way of meat cutting. Contamination by hands of operators, tools, cutting-boards, etc. is less than with other methods. The technique is also suitable for smaller operations. Final trimming of the meat cuts takes place on cutting tables as usual. When meat cuts are produced by muscle-boning it is often difficult to identify them, primarily because traditionally the size and shape of the accompanying bone has been used as the major means of identification.

Also, the traditional shape of muscle in a cut of meat is often determined because of its attachment to bone. Many conventional cuts of meat combine muscles because of their association, size and proximity to bone or general location. The basic principle of merchandising meat is to separate the tender from the less tender and to sell each according to its palatability characteristics and its possible method of preparation. Muscle-boning facilitates this type of merchandising.

Pork Cutting

Halving is done immediately after the animal has been dressed and every effort should be made to saw the carcass into equal sides through the centre of the backbone. The side to be cut should be laid on the cutting table with the inside up. The primal cuts of pork are: ham, fore-end or forequarter, loin and belly.

Hind foot: The hind foot is removed by sawing through the hock joint at a right angle to the long axis of the leg.

Ham: The ham may be removed in several ways to make either long-cut or short-cut hams. One procedure (short-cut) is to locate the division between the second and third (or the third and fourth) sacral vertebrae and saw perpendicularly to the long axis of the ham. After the

bone has been severed with the saw, the knife is used to complete the removal of the ham. The ham is further trimmed by removal of the tail bone on one side and the flank on the other side. Commonly a skinned ham is produced by removal of three-fourths of the skin and fat from the rump end. For the production of special cured dried hams the skin is left on.

In order to obtain a long-cut ham the division is made between the last two (fifth and sixth) lumbar vertebrae. The long cut is composed of a rump or chump portion and a leg portion comprising centre section and shank portion. Nowadays more processors are removing the bones thus fabricating a boneless rump (chump) and a boneless ham. The ham is commonly merchandised in smaller portions (topside, silverside, thick flank, shank).

The cutting procedure of the ham is as follows. Remove tail bone and aitch bone and cut the rump off. Peel back the rind and associated fat to expose the topside muscle on the interior side of the leg. Separate the topside by following the natural seam between it and the silverside (outside portion of leg) and thick flank (front position of leg). The topside can then be sliced into steaks. This produces between five and six lean steaks depending on the thickness and weight required by the customer. The next step is to remove the leg bone (femur). The thick flank (knuckle) is cut from the silverside by following the natural seam. Remove the kneecap (patella) and the internal fat deposits before further preparation of the thick flank, e.g. for diced pork or steaks.

Forefoot: The forefoot is removed by sawing through the junction between the foreshank and the forefoot bone at a right angle to the length of the foot. This foot contains some muscle and is therefore more desirable than the hind foot for food.

Fore-end: Considerable variation exists as to where the fore-end is removed. Generally one to three ribs are left on the pork fore-end. Locate the division between the third and fourth ribs from the head end and saw perpendicularly to the length of the backbone. The fore-end is trimmed of the hock which is cut off about halfway up the leg and about two-thirds of the skin and fat is removed from the butt or top end. Additionally the neckbone (all cervical and three thoracic vertebrae) and the jowl or cheek meat are removed.

The jowl is removed by a straight cut parallel to the cut that separates the fore-end from the side just behind the site where the ear was removed. The fore-end may be divided into two cuts (spare-rib, also called blade Boston, and hand, also called arm picnic) by sawing just below the exposed lower end of the blade-bone parallel to the top of the shoulder. The spare-rib can be sliced into steaks or used as a roast. It can easily be made into a boneless cut by removing the corner of the blade-bone.

Besides this method some other ways of cutting and boning the pork fore-end exist. In order to obtain boneless cuts (shoulder and neck-end) from the fore-end the following technique is recommended. Seam the shoulder carefully from the rest of the side, leaving the rind and associated fat behind. Release the under-blade steak and remove the blade-bone (scapula) and the shoulder-bone (humerus). Separate the main muscle block from the smaller group. The smaller group, after trimming the fat off, can be used for dicing.

The main shoulder block should be trimmed of excessive connective tissue. It can be separated further into the blade and feather muscles and the main shoulder muscle. These can then be sliced into a number of boneless steaks. The group of muscles on either side of

the spinous processes of the neckbone and the two or three following segments of the backbone is called the neck-end. The neck-end is loosened from the backbone and after trimming off excessive rind, fat and any adhering ragged edges it can be cut into attractive steaks.

Loin: The middle or centre section of the pork side is divided into loin and belly by a straight cut from the edge of the tenderloin muscle on the ham end through a point on the front rib tight against the protruding edge of the split backbone. The fat back (skin and excess fat) is removed from the loin so that a complete fat cover about 0.5 cm thick remains. Starting along the backbone side at the shoulder end, cut and lift the fat over the curve of the loin muscles without cutting into the lean. The loin can be roasted whole, cut into smaller roasts or cut into chops. Shoulder, rib, loin and sirloin chops are made from the loin. Chops for broiling or frying should be cut 1.3–1.9 cm thick. Thicker chops may be made and a pocket cut into them for stuffing.

Belly: Separate the spare-ribs from the belly by cutting closely underneath the ribs beginning at the flank end. Prepare the bacon side from the belly by removing any thin or ragged pieces of lean. Turn the belly over and remove the lower edge with a straight cut just inside of the teat line. Trim the flank edge of the belly to square the whole piece to prepare it for curing.

Lamb Cutting

This procedure as described may also be followed for the processing of deer, goats, sheep or other animal carcasses of similar size.

Cooling

All lamb carcasses should be promptly chilled and kept at

a low temperature (-2° to 2°C) until cut and utilised. Do not permit lamb carcasses to freeze within a day after slaughter or the meat may toughen. Lamb carcasses can be cut into retail cuts after they have been chilled for 24 to 48 hours.

Carcass

Lamb carcasses are generally not split into halves after dressing because they are not thick enough in any location to create cooling problems. Begin cutting the lamb carcass by removing the thin cuts, i.e. flank, breast and foreleg. Lay the carcass on the cutting table and mark one side from the cod or udder fat in front of the hind leg to the elbow joint. After removing the thin cuts from both sides, remove the kidneys, kidney fat and diaphragm. Next the carcass is turned over and the neck removed either in thin slices to be braised or in one piece to be added to stew or to be boned and ground.

The trimmed carcass can then be separated into four primal cuts, each with different characteristics. A cut between the fifth and sixth rib removes the shoulder. Another cut between the twelfth and thirteenth (last) rib separates the rib from the loin. The loin and legs are separated just in front of the hip bones by cutting through the back where the curve of the leg muscles blends into the loin.

Legs: Split the legs through the centre of the backbone. Trim off the flank and cod or udder fat. Utilise the saw and knife to remove the backbone from the leg. The leg may be further trimmed by cutting through the knee-joint which is located about halfway between where the muscles of the shank end and the muscles of the lower leg begin. Work the knife and cut through the joint. Several sirloin chops may be cut from the loin end of the

leg. Legs may either be prepared with the bone in or the bones completely removed and the leg rolled and tied.

Loin: The loin is usually split through the middle of the backbone and chops are cut perpendicularly to the backbone. Lamb chops are cut about 2.5 cm thick. Double or "English" chops are made from a loin that has not been split. Remove the fell or connective tissue covering before cooking chops.

Rib: The rib of lamb is prepared by sawing through the ribs on both sides of the backbone. The main portion of the backbone is then removed with a knife. Rib chops are easily made by cutting between the ribs. Remove the fell before cooking the chops. The breast portion may be barbecued in one piece or made into riblets by cutting between the ribs.

Shoulder: After splitting through the backbone, the shoulder may be roasted as is, made into chops, or boned and rolled into a roast. Arm chops should be made first by cutting parallel to the surface where the foreleg and breast were removed. Blade chops are made by cutting between ribs and sawing through the blade- and backbones.

To prepare a boneless shoulder, first remove the ribs and backbone by cutting closely underneath the ribs, backbone and neck vertebrae. Next from the rear surface cut along the inside of the blade-bone to expose it and the armbone. Cut along the edges of the bones and remove them. Roll the meat and tie it securely with clean twine. The boneless shoulder may also be made into a pocket roast and stuffed with ground lamb or other dressing. The edges of the pocket roast are stitched together.

Shanks: Both the fore- and hind shanks when removed can be barbecued, cut into pieces for stew or boned and the meat ground.

Lean trimmings: Lean trimmings of lamb in chunks are suitable for stews or to be marinated and used for special roasts. Other lean trimmings can be ground and used as one would prepare ground veal or beef.

Chilled Meat Marketing

Chilled meat is usually kept for the sale in refrigerated display cabinets, either unwrapped or portioned and packaged for self-service outlets. Refrigerated display cabinets may have fan-assisted convection and/or natural convection. Fan-assisted types are better able to maintain a lower temperature as they are less affected by draughts. Cabinets should be stacked to maintain a good air flow around all meat.

Do not store or display unwrapped cooked and raw meat together. Use separate refrigerators, display cabinets etc. to avoid cross-contamination. Raw-meat exudate on to cooked meat gives an explosive bacterial growth. Simple packaging of fresh meat with plastic foil has become very popular with the availability of suitable and inexpensive film. The main objective of simple packaging is to provide hygienically protected portioned meat for self-service retail outlets. But the meat portions must also satisfy the customers' preference for bright red fresh meat.

This colour is due to the pigment myoglobin loosely binding oxygen to form oxymyoglobin. For this colour to develop and be maintained, the wrapping film must have a high-oxygen permeability. To avoid desiccation of the cut surface, the film should have a low-moisture permeability. After a time the cut surface becomes more brown as a result of myoglobin binding the oxygen more tightly to form metmyoglobin. This may take up to three

days depending on the temperature, the number of bacteria and other conditions.

Simple packaging for retail sale in self-service outlets usually involves placing the meat portion in a plastic tray and overwrapping with a clear plastic film. Plastic trays are more hygienic than cardboard. The portions cut should be based on local demand and only a day's sales should be cut at a time. The principal object of this type of simple packaging from a hygiene point of view is to reduce contamination from airborne micro-organisms.

High standards of hygiene are required in the cutting and packaging operations. On large pieces of meat the bacteria mainly colonise the outer surfaces. When meat is cut even with a clean knife they will be spread on to the freshly cut moist surface and multiply rapidly. This is not an argument for relaxing hygiene standards, rather it underlines the need not to add to the bacterial load by further contamination. All surfaces and tools in the cutting and packaging room must be kept thoroughly clean.

Packaging materials should be stored in hygienic conditions protected from dust and attack from insects or vermin. It is most important that personnel involved in cutting and packaging pay particular attention to personal hygiene as they are the most likely source of food-poisoning pathogens which may survive better in the package environment than on unpackaged meat. This is in part due to the packaging preventing surface desiccation. The moist surface favours bacterial growth as does the high relative humidity that builds up within the pack.

It is important to retard bacterial growth by maintaining a low temperature during the display life of the packs. Overwrapping actually increases the meat

temperature as the layer of trapped air acts as an insulator. Heat generated by light warms the upper surface. Meat should be thoroughly cooled before packaging to help maintain a low temperature during its display life.

Mincing meat spreads bacteria on the surface all through the meat which therefore has a shorter shelf-life than cuts. Mince may be packaged and overwrapped but the mincer must be kept scrupulously clean and the packs kept well chilled. Only small quantities of mince should be prepared at a time. Cooked meats, which typically have much lower bacteria counts than fresh, are more open to attack from airborne micro-organisms as these will be faced with little competition. Packaging is therefore particularly beneficial in preventing this type of contamination for cooked meats.

Bacteria introduced during cutting and packaging face little competition and may be of the food-poisoning type if personal hygiene is poor. If very high standards of hygiene cannot be maintained then a pasteurising treatment after packaging will be necessary. Even this, however, will not guarantee destroying *Bacillus* and *Clostridium* spp. if these have been introduced.

Cooking Methods

Primarily because of natural tenderness or lack of tenderness, different cooking procedures are utilised to prepare the various cuts of meat correctly. Tender cuts are best cooked with dry heat, as by broiling, roasting or pan broiling. Less tender cuts are tenderised by cooking with moist heat. Connective tissue is softened and made tender by cooking slowly in moisture.

Temperature control is important in meat cookery. Meat loses moisture, fat and other substances such as

soluble proteins during cooking. Cooking losses can be minimised by controlling the cooking temperature and the final internal temperature of the meat. Higher oven and higher internal temperatures increases shrinkage. Whenever possible a meat thermometer should be used to determine accurately the degree of doneness of meat. Time and temperature guides can be used to ascertain doneness, but cooking time is affected by fat, bone and moisture content and the shape and size of the cut. The basic types of meat cookery follow.

Broiling

Broiling is recommended for all tender cuts and for best results:

- Set the oven for broiling
- Place thin cuts of meat on a rack at a distance from the heat equal to two times the thickness of the cut plus 2.5 cm
- Broil steaks, chops or patties for approximately one-half the desired cooking time before turning
- Season and serve at once.

Pan-broiling

Pan-broiling is recommended for tender cuts suitable for broiling. For best results:

- Place meat in a hot frying-pan or on a griddle
- Do not add fat or water
- Cook slowly over moderate heat, turning occasionally
- Pour off or remove fat as it accumulates

- Brown meat on both sides
- Avoid overcooking.

Roasting

Roasting is recommended for large, tender cuts. Some beef cuts suitable for roasting are rib and top sirloin roasts. For best results:

- Season with salt and pepper as desired
- Place the meat, fat side up, on a rack in an open shallow roasting-pan
- Insert a meat thermometer so that the bulb is in the centre of the largest muscle without touching bone.
- Add no water and do not cover
- Roast at oven temperature of 176°C to desired internal temperature.

Meats are usually cooked to degrees of doneness as follows:

- Rare 60°C
- Medium 71°C
- Well done 77°C

Pan-frying

Pan-frying is usually recommended for tender cuts 2.5 cm thick or less. For best results:

- Place meat in a hot frying-pan or on a griddle
- Fat may be added
- Cook slowly over moderate heat, turning occasionally

- Allow fat to accumulate
- Brown meat on both sides
- Avoid overcooking.

Braising

This method is best used for less tender cuts such as beef round or chuck steak, pot roast, stew or short ribs. For best results:

- Use a heavy pan
- If desired, brown meat slowly on all sides with sufficient fat to keep meat from sticking
- Season with salt, pepper, herbs or spices
- Add a small amount of liquid
- Cover tightly
- Cook slowly over low heat on a stove burner or in a moderate oven until meat is tender.

Braising with large cuts is often called pot-roasting and with thin cuts may be known as Swissing.

Simmering

This method consists of cooking a small amount of meat with a large amount of water. For best results the container should be tightly covered and the meat cooked slowly below the boiling point until tender. This method is used for the production of soups to which vegetables, grains or pasta products may be added.

Hygiene Practices in Slaughtering and Meat Handling

Slaughtering Equipment

Slaughtering equipment, particularly for smaller-scale operations, need not be elaborate and expensive. The amount of equipment will depend on the slaughtering procedures employed. If possible, all equipment should be made of stainless steel or plastic, be rust resistant and easily cleaned and sanitised. Equipment which does not get in contact with the meat (e.g. overhead rails, working platforms, knocking pen) is usually made of galvanised steel. Basic equipment needed for the slaughtering operation:

- stunning gun, electrical head tongs or simple stunning equipment for direct blow
- *knives*: sticking - 15 cm sharpened on both sides
skinning - 15 cm curved
- a sharpening steel
- oil or water sharpening stone
- scabbard and belt for holding knives
- meat saw - hand or electric and cleaver

- block and tackle or chain hoist strong enough to hold the weight of the animal to be slaughtered
- pritch, chocks or skinning rack (dressing cradle)
- a strong beam, tripod or track 2.4 to 3.4 m from floor
- spreader - gambrel or metal pipe
- several buckets
- working platforms
- scalding barrel or tank
- pot, barrel or system for boiling water
- bell scrapers
- solid scraping table or platform
- thermometer registering up to 70°C
- hog or hay hook
- torch or flame for singeing

The last seven items indicate additional equipment required when hogs are scalded and scraped rather than skinned. Useful additional equipment:

- knocking pen
- bleeding hooks (for vertical bleeding)
- blood-catching trough
- wash trough (tripe) Sanitation of hands and tools:
- hand wash-basin
- implement sterilisers

Means should be available to clean thoroughly all equipment coming into contact with carcasses or meat. Implement sterilisers are stainless-steel boxes holding hot (82°C) water, shaped to suit particular equipmentknives,

cleavers, saws, etc. Knife sterilisers should be placed in positions where every operator who uses a knife has immediate access. Handles as well as blades must be sterilised. Each operator should have at least two knives etc., one to use while the other sterilises. Failure to sterilise all knives and equipment regularly will result in carcass contamination. Bacteria will be transferred from the hide to the carcass and from carcass to carcass.

Treatment of Animals

Stress in its many forms, e.g. deprivation of water or food, rough handling, exhaustion due to transporting over long distances, mixing of animals reared separately resulting in fighting, is unacceptable from an animal welfare viewpoint and should also be avoided because of its deleterious effects on meat quality. The most serious consequence of stress is death which is not uncommon among pigs transported in poorly ventilated, overcrowded trucks in hot weather.

From loading on the farm to the stunning pen animals must be treated kindly, and the lorries, lairages and equipment for livestock handling must be designed to facilitate humane treatment. Stress immediately prior to slaughter, such as fighting or rough handling in the lairage, causes stored glycogen (sugar) to be released into the bloodstream. After slaughter this is broken down in the muscles producing lactic acid. This high level of acidity causes a partial breakdown of the muscle structure causing the meat to be pale, soft and exudative (PSE). This condition is mostly found in pigs.

Long-term stress before slaughter such as a prolonged period of fighting during transport and/or lairage leads to exhaustion. The sugars are used up so that less is available to be broken down and less lactic acid is

produced. The reduced acidity leads to an abnormal muscle condition known as dark, firm and dry (DFD) in pigs or dark cutting in beef. The condition is rarer in lamb. Such meat has a high pH (above 6.0) and spoils very quickly as the low acidity favours rapid bacterial growth.

An electric goad should be used rather than a stick or tail-twisting not only to avoid stress but also to prevent carcass bruising. Grabbing sheep by the fleece also causes bruising. To avoid fighting, animals not reared together must not be mixed during transport and lairage. Load and unload using shallow stepped ramps to avoid stumbles. Trucks should be neither over- nor underloaded. Overloading causes stress and bruising due to crushing. Underloading results in animals being thrown around and falling more than necessary. Drivers should not corner at excessive speed and must accelerate and decelerate gently.

The lairage should have small pens. Corridors must curve and not bend sharply so that stock can see a way forward. Stock must not be slaughtered in sight of other stock. Plenty of clean water must be available. The lairage must be well lit and ventilated. Do not hold stock in lairage for more than a day. Only fit, healthy stock may be slaughtered for human consumption. Fasting before slaughter reduces the volume of gut contents and hence bacteria and therefore reduces the risk of contamination of the carcass during dressing.

It is usually sufficient for the animals to receive their last feed on the day before slaughter. Stock should have a rest period after arrival at the slaughterhouse. However, long periods in the lairage can lead to DFD if the animals are restless and fighting or mounting. Animals should be as clean as possible at slaughter. Producers should wash

their animals before leaving the farm. Trucks used for transport must be washed after each load and the lairage at the slaughterhouse should be kept clear of faecal matter and frequently washed.

Stunning and Bleeding

Most countries have legislation requiring that animals are rendered unconscious (stunned) by a humane method prior to bleeding. Exceptions are made for religions which require that ritual slaughter without prior stunning is practised, provided the slaughter method is humane. Stunning also makes sticking (throat-slitting) less hazardous for the operator. The animal must be unconscious long enough for sticking to be carried out, and for brain death to result from the lack of blood supply.

Stunning Methods

Direct blow to skull using a club or poleaxe: The blow must be dealt with precision and force, so that the skull is immediately smashed, causing instantaneous unconsciousness. In cattle the aiming point is in the middle of the forehead in line with the ears, where the skull is thinnest. Horses have thinner skulls and are therefore easier to stun by this method. In sheep and goats the brain is more easily reached from the back of the neck. Pigs have a well-developed frontal cavity so the blow should be aimed slightly above the eyes.

Slaughtering mask: A bolt held in the correct position by the mask is driven into the animal's brain by a hammer blow. The device is usually fitted with a spring which returns the bolt to its original position.

Free bullet fired from a pistol into the skull is effective but unsafe: This method has been used on horses and cattle.

Captive-bolt pistols fitted with a blank cartridge are effective on cattle and sheep but not pigs whose skulls are thicker: After firing, the bolt returns to its original position in the pistol. The bolt may or may not be designed to penetrate the skull. With penetrating types the brain becomes contaminated with hair, dirt and bone fragments. If brains are to be saved as edible tissue then the non-penetrating type with a mushroom-shaped head should be used.

Electrical stunning: An electric current of high frequency but, in the case of manually operated equipment, of relatively low voltage (60–80 V) is passed through the brain of an animal for a few seconds to produce unconsciousness. If applied correctly a deep state of unconsciousness is invariably achieved. Strict safety rules must be observed. Head tongs are suitable for pigs and sheep but not for cattle.

The electrodes carried on the ends of the tongs must be accurately placed. Places where the skull is thick must be avoided. Electrical contact is impeded by hair and caked mud. Water or brine will improve contact but the head must not be completely wet otherwise the current will have a short-circuit path avoiding the brain. The electrodes must be applied with strong pressure.

Carbon dioxide stunning: Carbon dioxide stunning is used only in large pig abattoirs. Pigs are induced into a chamber and exposed to a concentration of 85 percent CO₂ for about 45 seconds. Although effective for anaesthetising sheep, it is impractical because of large amounts of CO₂ collecting in the wool and affecting operators on the killing line.

Bleeding after Stunning

The objectives of bleeding are to kill the animal with

minimal damage to the carcass and to remove quickly as much blood as possible as blood is an ideal medium for the growth of bacteria.

Sticking, severing the major arteries of the neck, should immediately follow stunning. Care must be taken not to puncture the chest cavity or it will fill with blood.

Cattle: Insert the sticking knife carefully just above the breastbone at 45° pointed toward the head. Ensure that the carotid arteries and jugular veins are severed in one movement.

Sheep: Draw the knife across the jugular furrow close to the head severing both carotid arteries. Alternatively, the knife may be inserted through the side of the neck, though this requires more skill.

Pigs: As for cattle but do not go in too far or a pocket of blood will collect at the shoulder. To reduce contamination by the scalding tank water the cut should be as small as possible.

Bleeding on a Rail

The most hygienic system of bleeding and dressing is to shackle the animal immediately after stunning, then hoist it on to a moving rail. The animal is stuck while being hoisted to minimise the delay after stunning. Bleeding continues until the blood flow is negligible when carcass dressing should begin without further delay. Blood for human use must be collected with special equipment to avoid contamination from the wound, the gullet of the knife.

A hollow knife directs blood away from the wound into a covered stainless-steel container without touching the skin or hide. The knife may be connected to a hose to reduce the risk of contamination. The hose may even be

connected to a pump to speed the blood flow. Between 40 and 60 percent of the total blood volume will be removed though this will be reduced if sticking is delayed. To prevent coagulation, citric acid solution made up with one part citric acid to two parts water is added at a rate up to 0.2 percent of the blood volume.

The main sources of contamination during sticking and bleeding include the knife, the wound and the food-pipe. The knife should be changed after each operation and returned to a steriliser. Cutting the hide of sheep and cattle and opening out to make a clean entry for the sticking knife reduces contamination from the wound. If the food-pipe is pierced semi-digested food may be regurgitated contaminating the blood and neck wound.

Horizontal Bleeding

Horizontal bleeding is claimed to give faster bleeding rates and a greater recovery of blood. This may be due to certain organs and blood vessels being put under pressure when animals are hoisted, thus trapping blood and restricting the flow. Bleeding on the floor is very unhygienic. The operation should take place on a specially designed, easily cleaned stainless-steel table which should be cleaned frequently. If blood is to be saved it must not come in contact with the table before reaching the collecting vessel.

Bleeding without Stunning

The Jewish and Muslim religions forbid the consumption of meat which was killed by any method other than bleeding. Since it is difficult to guarantee that all animals will recover consciousness after being stunned by any particular method, stunning is not generally allowed. There are exceptions, however. Some communities do

accept low-voltage electrical stunning. Because animals are fully conscious at the time of sticking, ritual slaughter may be less humane than sticking after stunning.

To reduce the suffering operators must be highly skilled so that a successful gash cut severing all the veins and arteries is made quickly at the first attempt. Different communities have different regulations as to the orientation of the animal at sticking, some favouring a position lying on its side, others insisting it lie on its back. The animal should not be hoisted until unconsciousness due to lack of blood supply to the brain is complete.

Scalding and Dehairing of Pigs

Scalding in water at around 60°C for about six minutes loosens the hair in the follicle. Too low a temperature and the hair will not be loosened and too high a temperature and the skin will be cooked and the hair difficult to remove. The simplest equipment consists of a tank into which the pig is lowered by a hoist. The water is heated by oil, gas, electricity or an open steam-pipe. To check the effectiveness of the scald, rub the skin with the thumb to see if hair comes away easily. Some machines have the thermostatic controls and timers.

To reduce contamination, scalding water should be changed frequently, pigs should be as clean as possible at sticking, and bleeding should be fully completed before immersion. In large factories pigs are transported through scalding tanks with rotating bars or through long scalding tanks stretching from the sticking point to the dehairing point in the time required for an effective scald.

Dehairing is done with a specially formed scraper (bell scraper or knife). If the scald is effective all the hair can be removed by this manual method. Another simple

method is to dip the pig in a bath containing a hot resin adhesive. The pig is removed from the bath and the resin allowed to set partially when it is peeled off pulling the hair with it from the root. This is less labour-intensive than scraping and produces a very clean skin. After use the adhesive is melted again, strained to remove the hair and returned to the tank.

Another method of removing dirt and hair in one operation is to skin the carcass though this is only done when the skin is required for leather goods. With the simple scalding tank, dehairing and scalding may be combined in one operation. Inside the tank are rotating rubber-tipped paddles which are started after closing the lid. As the hair is loosened by the scalding water it is removed by the rubbing effect of the paddles against the skin.

Singeing removes any remaining hairs, shrinks and sets the skin, decreases the number of adhering microorganisms and leaves an attractive clean appearance. It may be done with a hand-held gas torch. Automated systems transport the pig into a furnace and leave it long enough for an effective singe. After singeing, black deposits and singed hairs are scraped off and the carcass is thoroughly cleaned before evisceration begins.

Skinning

Cattle

The outer side of the hide must never touch the skinned surface of the carcass. Operators must not touch the skinned surface with the hand that was in contact with the skin.

Combined horizontal/vertical methods

Head: After bleeding, while the animal is still hanging

from the shackling chain, the horns are removed and the head is skinned. The head is detached by cutting through the neck muscles and the occipital joint. Hang the head on a hook. Lower the carcass on its back into the dressing cradle.

Legs: Skin and remove the legs at the carpal (foreleg) and tarsal (hind leg) joints. The forelegs should not be skinned or removed before the carcass is lowered on to the dressing cradle or the cut surfaces will be contaminated. The hooves may be left attached to the hide.

Flaying: Cut the skin along the middle line from the sticking wound to the tail. Using long firm strokes and keeping the knife up to prevent knife cuts on the carcass, skin the brisket and flanks, working backwards toward the round. Skin udders without puncturing the glandular tissue and remove, leaving the supermammary glands intact and attached to the carcass. At this point raise the carcass to the half-hoist position, the shoulders resting on the cradle and the rump at a good working height.

Clear the skin carefully from around the vent (anus) avoiding puncturing it and cut the abdominal wall carefully around the rectum. Tie off with twine to seal it. Skin the tail avoiding contamination of the skinned surface with the hide. Raise the carcass free of the floor and finish flaying.

Vertical methods

High-throughput plants have overhead rails which convey the carcass from the sticking point to the chills. Hide removal is carried out on the hanging carcass. The operations are as in the combined horizontal/vertical method, but as it is not possible to reach the hide from ground level more than one operator is needed. A single

operator may work with a hydraulic platform which is raised and lowered as required. Automatic hide pullers are used in high-throughput slaughterhouses. Some types pull the hide down from the hind, others from the shoulders upwards toward the rump.

Automation of hide removal reduces contamination since there is less handling of the carcass and less use of knives. Moving overhead rails also improve hygiene by reducing carcass contact with operators, equipment such as dressing cradles and with each other since carcasses are evenly spaced.

Small Ruminants

Sheep fleeces can carry large volumes of dirt and faeces into the slaughterhouse. It is impossible to avoid contamination of sheep and lamb carcasses when the fleece is heavily soiled. The fleece or hair must never touch the skinned surface, neither must the operator touch the skinned surface with the hand that was in contact with the fleece.

Combined horizontal/vertical method

The animal is turned on its back and cuts are made from the knuckles down the forelegs. The neck, cheeks and shoulders are skinned. The throat is opened up and the gullet (food-pipe) is tied off. The skin on the hind legs is cut from the knuckles down to the tail root. The legs are skinned and the sheep is hoisted by a gambrel inserted into the Achilles tendons. A rip is made down the midline and skinning proceeds over the flanks using special knives or the fists. The pelt is then pulled down over the backbone to the head. If the head is for human consumption it must be skinned or it will be contaminated with blood, dirt and hairs.

Moving crutch and rail system: The hanging carcass is lowered on to a horizontal conveyor made up of a series of horizontal steel plates, bowed slightly and divided into sets large enough to cradle a single animal. Two operators usually work together on each lamb performing the legging operations and opening the skin to the stage where it can be pulled off the back. When the gambrel is inserted into the hind legs it is hoisted on to a dressing rail.

Vertical method

At sticking the animal is shackled by one hind-leg and left to bleed. Dressing commences with the free leg which is skinned and the foot removed. A gambrel is inserted into this leg and hung on a runner on a dressing rail. The second leg is freed from the shackle, skinned and dressed, then hooked on to the other end of the gambrel. The skin is opened down the midline and cleared from the rump. A spreader frame (a bar U-shaped at each end) spreads the front legs to simplify work on the neck, breast and flanks.

The front toes are held in each end of the frame which is then slung up on to a separate travelling hook. The animal is therefore suspended by all four legs belly uppermost. Skinning continues as in the combined horizontal/vertical method. To clear the shoulders and flanks, the forelegs are freed from the spreader and the feet removed, the animal returning to a vertical position. The skin can now be completely pulled off, including the head if this is for consumption, though this takes some work with the knife. In both methods, after fleece removal the vent and food-pipe are cleaned and tied off.

Evisceration

¹With all species care must be taken in all operations not

to puncture the viscera. All viscera must be identified with the carcass until the veterinary inspection has been passed. After inspection the viscera should be chilled on racks etc. for better air circulation.

Cattle

The brisket is sawn down the middle. In the combined horizontal/ vertical system this is done with the animal resting on the cradle. The carcass is then raised to the half-hoist position and when hide removal is complete the abdominal cavity is cut carefully along the middle line. The carcass is then fully hoisted to hang clear of the floor so that the viscera fall out under their own weight. They are separated into thoracic viscera, paunch and intestines for inspection and cleaning. If any of the stomachs or intestines are to be saved for human consumption, ties are made at the oesophagus/stomach, stomach/duodenum boundaries, the oesophagus and rectum having been tied off during hide removal. This prevents cross-contamination between the paunch and the intestines.

Small Ruminants

A small cut is made in the abdominal cavity wall just above the brisket, and the fingers of the other hand are inserted to lift the body wall away from the viscera as the cut is continued to within about 5 cm of the cod fat or udder. The omentum is withdrawn, the rectum (tied off) loosened, and the viscera freed and taken out. The food-pipe (tied off) is pulled up through the diaphragm. The breastbone is split down the middle taking care not to puncture the thoracic organs which are then removed.

Pigs

Loosen and tie off the rectum. Cut along the middle line

through the skin and body wall from the crotch to the neck. Cut through the pelvis and remove the bladder and sexual organs. In males the foreskin must not be punctured as the contents are a serious source of contamination. All these organs are considered inedible. Remove the abdominal and thoracic viscera intact. Avoid contact with the floor or standing platform. The kidneys are usually removed after the carcass has been split down the backbone. The head is usually left on until after chilling.

Carcass Splitting

Cattle

Work facing the back of the carcass. Split the carcass down the backbone (chine) with a saw or cleaver from the pelvis to the neck. Sawing gives a better result but bone dust must be removed. If a cleaver is used, it may be necessary to saw through the rump and loin in older animals. The saw and cleaver should be sterilised in hot (82°C) water between carcasses. Power saws increase productivity.

Pigs

These are suspended and are split down the backbone as for cattle, but the head is generally left intact.

Sheep

Sheep and lamb carcasses are generally sold entire. If necessary they can be split by saw or cleaver, but a saw will probably be necessary for older animals.

Carcass Washing

The primary object of carcass washing is to remove

visible soiling and blood stains and to improve appearance after chilling. Washing is no substitute for good hygienic practices during slaughter and dressing since it is likely to spread bacteria rather than reduce total numbers. Stains of gut contents must be cut off. Wiping cloths must not be used. Carcass spraying will remove visible dirt and blood stains.

Water must be clean. Soiled carcasses should be sprayed immediately after dressing before the soiling material dries, thus minimising the time for bacterial growth. Under factory conditions bacteria will double in number every 20 or 30 minutes. In addition to removing stains from the skinned surface, particular attention should be paid to the internal surface, the sticking wound and the pelvic region.

A wet surface favours bacterial growth so only the minimum amount of water should be used and chilling should start immediately. If the cooler is well designed and operating efficiently the carcass surface will quickly dry out, inhibiting bacterial growth. Bubbling of the subcutaneous fat is caused by spraying with water at excessively high pressure, which may be due to the pressure in the system or a result of holding the spray nozzle too close to the carcass.

Carcass Dressing

The object of carcass dressing is to remove all damaged or contaminated parts and to standardise the presentation of carcasses prior to weighing. Specifications will differ in detail for different authorities. Veterinary inspection of carcasses and offal can only be carried out by qualified personnel. Where signs of disease or damage are found the entire carcass and offal may be condemned and must not enter the food chain, but more often the veterinarian

will require that certain parts, for instance those where abscesses are present, be removed and destroyed. Factory personnel must not remove any diseased parts until they have been seen by the inspector otherwise they may mask a general condition which should result in the whole carcass being condemned. Any instructions from the inspector to remove and destroy certain parts must be obeyed.

Refrigeration of Carcasses

Carcasses should go into the cooler as soon as possible and should be as dry as possible. The object of refrigeration is to retard bacterial growth and extend the shelf-life. Chilling meat post-mortem from 40°C down to 0°C and keeping it cold will give a shelf-life of up to three weeks, provided high standards of hygiene were observed during slaughter and dressing. Carcasses must be placed in the cooler immediately after weighing. They must hang on rails and never touch the floor. After several hours the outside of a carcass will feel cool to the touch, but the important temperature is that deep inside the carcass. This must be measured with a probe thermometer (not glass), and used as a guide to the efficiency of the cooling.

The rate of cooling at the deepest point will vary according to many factors including the efficiency of the cooler, the load, carcass size and fatness. As a general guide a deep muscle temperature of 6–7° C should be achieved in 28 to 36 hours for beef, 12 to 16 hours for pigs and 24 to 30 hours for sheep carcasses. Failure to bring down the internal temperature quickly will result in rapid multiplication of bacteria deep in the meat resulting in off-odours and bone-taint.

High air speeds are needed for rapid cooling but these will lead to increased weight losses due to evaporation unless the relative humidity (RH) is also high. However, if the air is near to saturation point (100 percent RH) then condensation will occur on the carcass surface, favouring mould and bacteria growth. A compromise between the two problems seems to be an RH of about 90 percent with an air speed of about 0.5 m/second. Condensation will also occur if warm carcasses are put in a cooler partially filled with cold carcasses.

The cooler should not be overloaded beyond the maximum load specified by the manufacturers and spaces should be left between carcasses for the cold air to circulate. Otherwise cooling will be inefficient and the carcass surface will remain wet, favouring rapid bacterial growth forming slime. Once filled, a cooler should be closed and the door opened as little as possible to avoid sudden rises in temperature. When emptied, it should be thoroughly washed before refilling. Personnel handling carcasses during loading and unloading operations should follow the strictest rules regarding their personal hygiene and clothing and should handle carcasses as little as possible.

Chilled meat must be kept cold until it is sold or cooked. If the cold chain is broken, condensation forms and microbes grow rapidly. The same rules about not overloading, leaving space for air circulation, opening doors as little as possible and observing the highest hygiene standards when handling the meat apply. An ideal storage temperature for fresh meat is just above its freezing point, which is about -1°C (-3°C for bacon because of the presence of salt). The expected storage life given by the International Institute of Refrigeration of various types of meat held at these temperatures is as follows:

<i>Type of meat</i>	<i>Expected storage life at - 1°C</i>
Beef	up to 3 weeks (4-5 with strict hygiene)
Veal	1-3 weeks
Lamb	10-15 days
Pork	1-2 weeks
Edible offal	7 days
Rabbit	5 days
Bacon	4 weeks (at - 3°C)

Under commercial conditions, meat temperatures are rarely kept at - 1°C to 0°C, so actual storage times are less than expected. The times would also be reduced if RH were greater than 90 percent. Meat should be placed in the refrigerator immediately following receipt. Any parts which show signs of mould growth or bacterial slime should be trimmed off and destroyed. Hands must be thoroughly washed after handling such trimmings and knives must be sterilised in boiling water.

The refrigerator should be thoroughly cleaned after finding such meat and should also be cleaned on a regular basis. Carcasses, quarters and large primals should not be cut into smaller portions before it is necessary as this will expose a greater surface area for bacteria to grow. Freshly cut surfaces are moist and provide a better medium for bacterial growth than the desiccated outer surfaces of cuts that have been stored for some time. An accurate thermometer should be placed in the refrigerator and checked regularly. The temperature should remain within a narrow range (0° to + 1°C).

Meat Transportation

Vehicles for transporting meat and carcasses should be considered as an extension of the refrigerated storage. The object must be to maintain the meat temperature at

or near 0°C. Meat should be chilled to 0°C before loading. Meat should hang on rails, not on the floor. If stockinettes are put on carcasses they must be clean. Meat trucks should not carry anything other than meat.

The refrigeration is usually produced by injecting liquid nitrogen or carbon dioxide (CO₂) into the compartment or by blowing air over CO₂ chunks (dry ice). The temperature in these vans can be set and controlled to minimise the temperature rise and to avoid condensation on the meat surface. Insulated vans without refrigeration may be refrigerated by adding dry ice. While this is a reasonably good alternative to the refrigerated truck it does not allow the temperature to be controlled.

Uninsulated vans and open trucks should not be considered as suitable transport for meat, particularly in hot climates. In addition to the temperature abuse, condensation will occur when the meat goes back into refrigeration, and in open trucks the meat is exposed to attack from insects. Loading and unloading should be done quickly. If there are any unavoidable delays then dry-ice blocks should be placed in the partly filled van.

Meat Handling without Refrigeration

Where refrigeration is unavailable either owing to financial or technical reasons (e.g. no power supply), the shelf-life of meat is reduced to days or hours, not weeks. Slaughter and dressing must be near the point of sale and it must be quick and clean. If carcasses and meat are kept in well-insulated rooms, the temperature can be reduced with dry-ice blocks, if these are available. Since it is easier to chill boneless cuts rather than whole carcasses, hot-boning should be considered.

Stock must be handled carefully to avoid producing high-pH meat which will spoil more quickly. Rooms used

for slaughter and handling meat must be clean and well ventilated, but out of direct sunlight, dust-free and verminfree (rodents and insects). Hot water (82°C) must be available to clean all equipment and surfaces and personnel must work very ahygienically. Receive all blood into sealed containers and have separate skips on wheels for hooves, skins, green offal and trimmings.

Dressing on a vertical hoist will minimise contamination by floor or cradle contact. Let nothing drop on the floor, only into skips. Personal hygiene must be scrupulous. Any spills of gut contents on to the meat should be cut off, but careful work will avoid this. The dressed carcass should be hung on rails. If beef is quartered to facilitate handling, the cut surface is at risk. Red offal should be hung on hooks. Any offal processing must be in rooms away from meat-handling facilities. Intestines for human consumption must be thoroughly cleaned and washed.

Meat should be put on sale within a day of slaughter. If it has to be held it should be hung in a clean, well-lit hall with good ventilation. Insects, rodents and birds must be kept out, dust must not blow in. Trays of offal should be on shelves, not on the floor. Barrows for wheeling carcasses and quarters are better than carrying on shoulders, as they can be cleaned frequently. All staff must wear clean clothing and observe strict personal hygiene. Transport of non-refrigerated meat is very hazardous. If meat is to be put in stockinettes and sacks these must be very clean. Meat should be on rails in the truck or wagon, and it is not advisable to carry it more than a day's journey before sale.

Basic Techniques in Meat Processing

Meat is animal tissue which is used as food. Most often it refers to skeletal muscle and associated fat, but it may also refer to non-muscle organs, including lungs, livers, skin, brains, marrow, and kidneys. Other animal tissues used as food, and also to some extent in meat processing, are the internal organs including the blood.

Muscle Tissue

The structural unit of muscle is a specialised cell, the muscle fibre, which constitutes 72-92 percent of the muscle volume. The membrane surrounding the muscle fibre is called the sarcolemma and the intracellular substance the sarcoplasm. The muscle fibre is composed of many myofibrils, which consist of thick and thin filaments (myofilaments). The special arrangement of these and the bands of myofibrils give the fibre a striated appearance under a microscope (cross-striated muscle).

The filaments consist almost entirely of the myofibular proteins actin (thin 20-25 percent) and myosin (thick 50-55 percent). Although they make up only .7

percent of muscle weight, they are mainly responsible for a very important property of meat, its ability to retain water and bind added water (water-holding capacity, WHC). The water-holding capacity is of particular importance in meat processing.

Connective Tissue

Connective tissues are distributed throughout all body components -skeleton, skin, organs, fat, tendons and muscles. There are three kinds of connective tissue fibre: collagen, reticulin and elastin. Collagen constitutes 20-25 percent of total protein, and has a major (negative) influence on meat tenderness. Skin (from pigs only) has excellent swelling and binding abilities owing to its high collagen content. It is therefore ideal for meat products such as emulsion-type cooked sausages provided it is properly scalded, completely dehaired, usually singed, scraped, washed and de fattened.

Fatty Tissues

The main fatty tissue deposits are in septa between muscle bundles (intramuscular fat), in spaces between muscles (intermuscular) and between skin and muscles (subcutaneous or backfat). Fat depots are also found around internal organs. The main depot is found around the kidneys (perirenal, leaf or kidney fat). Fatty tissues can be graded as "firm" (backfat, jowl and brisket) and "soft" fatty tissues (leaf perirenal fat) depending mainly on their connective tissue content.

Internal Organs

Depending on local regulations and eating habits, the following are commonly used in sausage manufacture:

- Heart after removing the pericardium is used as any other kind of meat.
- Liver is used for making various types of liver sausage and paste, because its proteins have high emulsifying capacity.
- Tongue trimmed of all the hyoid bones, tonsils, and mucous membranes, can be cured and dried whole, used to make meat batter, or cured and canned (ox or pork tongues).
- Lungs. Beef lungs can be used to make cooked sausages. Pork lungs are frequently not fit for human consumption as they can be contaminated by scalding water.
- Kidneys are often contaminated to a certain extent with heavy metals or other residual substances and the consumption in higher quantities is not recommended in some countries.
- Tripe is the rumen and reticulum of ruminants, opened and rinsed. All the dark tissues (internal linings) must be removed by cooking (62– 65°C).
- Stomach of pigs, properly cleaned, is used as a natural casing for cooked sausages.
- Intestines are mainly used as casings for various sausages.
- Blood is highly perishable and must be handled carefully to avoid contamination during collection. To prevent coagulation blood is either defibrinated or a solution of sodium citrate 1.6 percent or phosphate 1 percent is added. Blood plasma obtained by centrifuging should be cooled as quickly as possible to 0°C. Whole blood is used to make blood sausage, liver sausage, and blood

pudding. Blood plasma can be used for meat emulsions (batter).

All raw materials must be fit for human consumption. After inspection, final dressing, removal of condemned and dirty parts and washing, all meat and organs must be immediately hung on hooks and moved to a cooler to await processing. Carcasses may be fully or partially boned before chilling provided high hygienic standards are rigidly observed. A high degree of skill and special organisation of labour is required. If small-scale producers cannot chill the carcasses, they may use hot-boned meat for sausage production or meat batter. Hot-boned meat has a high WHC so the use of phosphate is avoided. However, beef must be processed within four hours and pork within one hour of slaughter.

Pre-slaughter stress may result in abnormal undesirable muscle conditions called "pale, soft and exudative" (PSE), and "dark, firm and dry" (DFD). PSE meat is frequently found in pork caused by a sudden stress before slaughter. Glycogen levels are raised in response to the stress so that post-slaughter glycolysis is elevated leading to a build-up of lactic acid and a rapid fall in muscle pH to below 5.8 within one hour. This results in partial protein denaturation reducing WHC and increasing drip loss.

A prolonged period of stress prior to slaughter such as fighting during transport and lairage causes exhaustion and the depletion of glycogen reserves. Post-mortem glycolysis and lactic-acid production are therefore reduced, the pH falls slowly and protein degradation is reduced. The resulting DFD meat which is found in pork and beef has a high WHC but spoils very quickly because the high pH and dry surface favour bacterial growth. Manufacturers must aim for uniform

quality of their meat products. To attain this, raw materials must be standardised for different qualities. Good-quality carcasses are usually divided into primal cuts (ham, shoulder, loin, neck, etc.).

The remainder of the carcass and trimmings from the primal cuts are standardised into different qualities of meat. Poorer-quality carcasses are used entirely for processing after being deboned and trimmed. Basic parameters for simple quality standards are size and shape of meat pieces, amount of visible fatty and connective tissues, and chemical composition. Meat must not contain skin, lymphatic glands, particles of bones, bristles, large blood vessels or blood clots.

Qualities of Meat

Meat pieces of relatively uniform size and shape, trimmed of connective tissue, with about 8 percent visible fatty tissue obtained from larger primal cuts, mostly hindquarter. It is used to make meat batter for sausages and high-quality canned products.

Meat pieces of irregular size and shape, partially trimmed of connective tissue with about 15 percent visible fatty tissue, obtained mostly from forequarters. It is used to manufacture meat batter, or medium-quality meat products.

Lean trimmings are small irregular pieces of meat, with pervading connective and fatty tissue (about 25 percent), obtained during deboning and trimming of primal cuts, Meats I and II, and meat parts of the head and flank. They are used to make meat batter for all kinds of medium-and low-quality cooked sausages.

Fatty trimmings are meat pieces containing about 50 percent visible fatty tissue, derived from all trimming

operations. They are used as the fatty ingredient of meat batter of medium and low quality.

Table 1. Approximate chemical composition of different qualities of raw materials

Raw materials	Water	Fat	Protein		Total
			Muscle	Connective tissue	
Meat I	71	10	16	3	19
Meat II	63	20	12	5	17
Lean trimmings	53	33	10	2	12
Fat trimmings	30	60	7	2	9
External beef fat	27	67	1	5	6
Internal beef fat	5	93	-	2	2
Jowl	17	78	3	3	6
Back fat	8	90	-	2	2
Side fat	32	60	7	1	8
Soft fat	5	93	-	3	3
Pork skin	55	15	0	30	30

Fatty Tissues

Ruminants

Firm (external) fatty tissues are trimmed from any part of the carcass and hump of zebu and are used as the fatty component of the meat batter or sausage mixture (mutton, goat, etc.) or all-beef higher-quality sausages.

Soft (internal) fatty tissues are perirenal and sacral in origin and are not generally used in sausages.

Pork

Jowl (firm) contains much muscular (even up to 30 percent) and connective tissues. It is suitable for

manufacturing dry sausages, summer sausages, salamis and emulsion-type sausages of the highest quality.

Back fat (firm) is used for semi-dry and dry sausages, and in frankfurter sausages of the highest quality.

Side fat (firm) contains about 60 percent visible fatty tissue. It is used to manufacture medium-quality cooked sausages made of uncooked or precooked materials.

Belly fat and leaf (soft) are used to make cooked sausages of low quality.

Impacts of Common Salt

Common salt (sodium chloride, NaCl, salt) which may be extracted from sea water (sea salt) or mined (rock salt), has three major effects upon meat.

Flavour enhancement of meat and meat products. The salty taste of a meat product depends on the relative amounts of salt and water. Typical ranges of salt concentration for various products are shown in Table 2. Products with less water require higher levels of salt concentration to achieve the same degree of saltiness.

Table 2. Typical concentration of salt in some meat products

<i>Finished meat products</i>	<i>Range of salt concentration (%)</i>
<i>Sausages</i>	
fresh and cooked	1.6-2.2
dry, small-diameter	2.4-3.8
dry, large-diameter	3.0-5.0
<i>Hams</i>	
cooked	2.6-3.2
dry	2.5-6.0

Functional properties of meat proteins. Depending upon its concentration salt can increase or decrease the WHC of a meat product. The dehydrating effect of salt is used for meat drying (lowering WHC). The opposite effect of increasing WHC is very important and results from the swelling and solubilising of the muscle proteins (actin and myosin).

Preservation. Salt is one of the most important food additives in food preservation. The salt concentration determines what types of microorganism, if any, can grow by dehydrating or by lowering the amount of water available for growth.

Meat Curing Agents

Nitrates. Sodium (NaNO_3) or potassium nitrate (saltpeter, KNO_3) allow cured meat colour to develop in products where drying is a long-term process. Nowadays, they are used less frequently because to be effective they have to be reduced to nitrites under the influence of bacterial enzymes, and this is a time-consuming process.

Nitrites are indispensable for meat curing, and no substitute has yet been found. Sodium nitrite (NaNO_2), a toxic substance, can be fatal even in small doses. For this reason they are often mixed with common salt at a concentration of about 0.6 percent (so-called "nitrite salt") when used for curing. If excessive levels of nitrite are accidentally reached the accompanying salty taste will be rejected by the consumer, thereby preventing nitrite poisoning.

The maximum amount of nitrite permitted in finished meat products is usually 200 ppm (parts per million, or mg per kg), or may be less subject to the type of meat product or country legislation. Saltpeter can be added to the nitrite salt at a concentration of 1 percent and used for

curing dry hams and dry sausages. Typical levels of nitrite and nitrate in meat products are shown in Table 3.

Table 3. Typical amounts of nitrite and nitrate in cured products

Curing agents	Amount of nitrite or nitrate in cured-meat products
Nitrite salt (99.4% NaCl + 0.6% NaNO ₂)	all-meat products, 100 ppm as nitrite dry hams, 150 ppm as nitrite
Salt peter (KNO ₃)	dry sausages, 100 ppm as nitrate low-sodium products, 100 ppm as nitrate
Nitrite salt + salt peter	dry hams, 600 ppm as nitrate

Three processes in meat curing are due to the effect of nitrites:

Cured-meat colour development is achieved when the muscle pigment (myoglobin) in an acid environment combines with nitric oxide (NO) (formed from nitrite) to form NO myoglobin. This reaction is affected by temperature, pH and oxygen-reducing agents. NO-myoglobin is relatively resistant to light and oxygen and, most importantly, it is heat stable. Thus, cured cooked meat and meat products maintain a bright red colour in contrast to uncured meat which turns grey after cooking. Nowadays it is considered that 3-50 ppm is sufficient to achieve colour in cooked sausages.

Cured-meat flavour development is based on various reactions between nitrite and the meat component. Typical flavour of cured-meat products is achieved with 20-40 ppm nitrite.

Preservative effect. Even in small doses (80-150 ppm), nitrite prevents the growth of numerous micro-organisms, and food-poisoning bacteria (*Clostridium botulinum*, salmonella, staphylococci, etc.). However, the effect of nitrite on shelf-life or prevention of food-

poisoning bacterial growth must not be overestimated and decreases with increasing storage temperature.

Common Spices

Spices act on the salivary and gastric glands to promote secretion, stimulating appetite and improving digestibility of meat products. Their use varies from country to country depending on the climate, customs and eating habits. There are spices whose taste and smell remain unchanged even after exposure to high temperatures (chilies and sage). Less resistant are cardamom, clove, pepper, rosemary and thyme, and the least heatresistant are coriander, mace, marjoram, nutmeg, allspice and ginger.

Useful additives

Phosphates are used to restore WHC to chilled meat, approximately to the same level as hot-boned meat. Certain countries forbid phosphates, whereas some allow their use only where there is a proven technological effect. Where permitted they should be restricted to 0.3–0.5 percent of the sausage mixture weight. Phosphates break down actomyosin into actin and myosin, which can be solubilised by salt to increase the WHC. This effect is retained even in cooked products, increasing the yield.

Ascorbic acid (vitamin C) and its salts (sodium ascorbate) contribute to the development of cured-meat colour. Sodium ascorbate is used in the manufacture of cooked sausages, made from uncooked or precooked raw materials. Ascorbic acid used is at a concentration of 0.03–0.05 percent, whereas sodium ascorbate is added at a concentration of 0.07 percent. Ascorbic acid is a strong reducing agent, enabling quicker formation of the NO-myoglobin so that less nitrite is needed, and it inhibits

the formation of an undesirable colour in cured-meat products.

Table 4. List of common spices used in sausage seasoning (g/kg sausage mixture)

Spice	Made of raw material		
	Dry sausages	Precooked	Uncooked
Allspice	0.5-1.0	0.3-0.5	0.1-1.0
Anise	-	0.1-0.3	-
Bay leaves	0.01	0.05-0.1	-
Caraway seed	0.2-1.5	0.2-0.7	-
Cardamon	0.1-0.5	0.2-0.5	0.3-0.5
Cinnamon	-	0.05-0.2	-
Cloves	0.2-0.5	0.1-0.3	0.3-0.5
Coriander	0.3-0.5	0.3-1.0	0.2-1.0
Cumin seed	0.1-0.5	0.2-1.5	0.2-0.7
Ginger	0.1-0.3	0.3-1.0	0.3-0.5
Mace	0.1-1.1	0.3-1.0	0.3-2.0
Marjoram	0.2-0.3	0.5-2.0	0.2-1.0
Nutmeg	0.2-0.5	0.3-1.0	0.3-1.0
Paprika	0.1-1.0	0.4-1.0	0.5-2.0
Pepper	1.0-4.0	1.5-3.0	1.0-4.0
Sage	0.05-0.5	0.1-0.3	0.05-0.5
Tarragon	-	0.1-0.3	0.05-0.5
Thyme	-	0.1-0.3	0.1-0.3
Garlic	according to taste	according to taste	
Onion	-	according to taste	
Mustard seed	0.5-2.0	0.1-0.2	

It must not be added to, or mixed with nitrites, because they will be broken down instantly and will become useless for curing. Thus, the nitrite salt must be added to meat at the very beginning, whereas ascorbic acid is always added at the end of comminution. Ascorbic acid decomposes rapidly especially in a humid warm environment. Its salt (sodium ascorbate), being more

stable, is often used in sausage production, as is erythorbic acid and its salt (sodium erythorbate).

Monosodium glutamate and other salts of glutamic acid are substances which improve the flavour of meat products, and are usually added in concentrations up to 0.2 percent.

Natural Smoke

Natural smoke is a very complex mixture, consisting of a great number of compounds, and is obtained by controlled combustion of moist sawdust at low temperature. Sawdust from hardwoods is most commonly used to generate the smoke. Nowadays, it is considered that optimal smoke composition is obtained at temperatures of 300–500°C. Smoke consists of gases (phenols, organic acids, carboniles and other compounds) and particles (pitch, tar, ash and soot). Gaseous components penetrate into a product through the casing to a certain level, and react with other components of meat products. Other components are deposited on to the surface. Smoke provides typical flavour and distinctive colour, and hardens the surface of the meat product.

All substances which are added to meat products must have food grade purity. They should not contain any food-poisoning bacteria, so must be treated according to the highest hygienic standards. It is important to keep them in properly closed containers or intact packages, away from any dampness and dust. They are usually kept in special, dry premises away from the workshop, in which they can be pre-weighed, blended and packed into plastic bags in the proportions required for sausage formulations. The nitrate must be kept under lock and key.

Dosage by hand of any non-meat ingredient is not allowed. The only correct way is with scales which must be checked occasionally for accuracy. One of the most serious consequences of failure to protect all non-meat substances is contamination with dirt, excreta from rodents, birds or other animals and infestation with insects.

Heat Treatment

During processing many meat products are subject to specific heat treatment. The first task of heat treatment is to reach satisfactory shelf-life by reduction of micro-organisms. The second task is to obtain desirable organoleptic characteristics, to preserve nutritive value and improve digestibility of the product.

Reduction of Micro-organisms

Bacteria are destroyed if exposed to sufficiently high temperatures for long enough. There is a direct relationship between bacteria survival and time of exposure to temperatures. As an example, if 10 000 000 bacteria (per ml) suspended in broth are exposed to heat (70°C), after the first five minutes 1 000 000 will survive (90 percent are destroyed), after the next five minutes the number of surviving will be 100 000 (again 90 percent are destroyed), and so forth. This tenfold reduction in bacterial numbers between fixed time intervals is called decimal reduction.

The time interval for decimal reduction varies between different bacteria and depends on the temperature applied. The number of bacteria present in a meat product just before the heat treatment (initial number) should be as low as possible so that a shorter time or lower temperature is needed to achieve a satisfactory shelf-life for the product. As sausage fillings

as well as most other meat products represent a very good medium for bacterial growth, they should immediately be exposed to heat treatment in order to prevent bacterial growth.

It is also important to perform all operations as quickly as possible, and to maintain the highest hygienic standards so that the initial bacterial count remains as low as possible. The manufacturer must always bear in mind that bacteria grow very fast. Their number may be doubled every 20 minutes.

Organoleptic Changes

These are caused by heat treatment (doneness, flavour, firmness, consistency and cured-meat colour development) are time-temperature-dependent processes. The basic effect of the heat treatment is coagulation of meat proteins. Between 70° and 80°C the majority of meat proteins are completely coagulated, forming a structural matrix which entraps fat and water droplets released during heat treatment. With coagulation of meat proteins, WHC is decreased and the meat loses a certain amount of water (thermal weight loss).

Those structural changes of proteins are responsible for characteristic firmness of heat-treated products. Frankfurters have an elastic firmness, and on reheating prior to consumption become even more firm. Products containing connective tissue become more tender owing to solubilisation of the collagen (gelling). Products such as paste which are in a liquid state prior to heating change for more viscous and spreadable consistency. Sausages made from larger meat pieces also attain a characteristic consistency. The exudate released during massaging or tumbling coagulates and binds the pieces of meat.

Such products (cooked hams, ham sausages) become sliceable. Heat treatment also makes products chewable. In addition to these physical changes resulting from heat treatment, some biochemical reactions also take place which contribute to the typical flavour of heat-treated products. Many compounds present in the raw material are broken down by heat to produce the characteristic flavour.

Fatty components give the meat product a distinctive flavour, specific to the animal species from which fat is obtained. Cured-meat colour is not stable unless the raw product is heat-treated. All these changes occurring during heat treatment give the product its typical overall sensation of doneness.

The duration of the heat treatment primarily depends upon the size and shape of the meat product. Treatment continues until the coldest point (innermost part) reaches the defined temperature. It is essential to check temperatures of the heating medium and of the innermost part of the products and to observe exact times.

Table 5. Heat treatment of different meat products

Product	Temperature	
	Heating medium	In product
	(°C)	
Fresh sausages, hamburgers	150-350	65-110
Sausages made of uncooked raw material	75-85	70-75
Sausages made of precooked raw material	80-98	85-90
Canned cured hams, shoulders and loins	75-85	70-75

Kind of Heat Treatment

Heat treatment by dry heat is performed in special ovens (roasting) or on a gridiron (grilling). Meat loaves and similar products are roasted. Meat patties, hamburgers and fresh sausages are grilled.

Heat treatment by hotwater is the most common and is usually performed in large cooking vats. When applied to canned hams or ham sausages, it is called pasteurisation.

Heat treatment by steam is one in special steam cabinets and is in particular applied in cases when treatment in cooking vats is not desirable because of substantial losses of aroma and flavour of the products into the cooking water.

Many faults are committed at the time of heat treatment. Following are some of them:

- *Undercooking* may be due to the temperature being too low, the time of treatment being too short, or both. The consequences are in a reduced shelflife due to spoilage and the possibility of food-poisoning. Spoilage results in a bad smell, discoloration, softened consistency and souring.
- *Overcooking* results from either too high a temperature or too long a duration or both. The consequences are increased cooking losses, fat separation in some sausages, undesirable changes of flavour and a softer consistency.

In order to keep the initial bacterial numbers as low as possible it is important to keep the temperature of the raw materials as low as possible before heat treatment. After filling sausages and mixing other meat products heat treatment must be applied immediately.

Raw and Dry Meat Pieces

These are prepared from primal cuts with or without bones. They are cured and dried without heat treatment and must be produced from wellrefrigerated carcasses. This process is based on two principles: the stabilisation of the product by decreasing water activity and adequate ripening. Decreasing water activity (= amount of water available for microbiological growth) is achieved by penetration of salt into the meat pieces and consequent dehydration. With 3-5 percent salt penetration, 5-9 percent of the water will migrate out of the meat.

Dehydration continues during drying and ripening and prevents bacterial growth. Nitrite, which is either added directly or formed from nitrate, also contributes to this bacteriological effect. If these preservative conditions are completed, the finished dry product will be bacteriologically stable and need not be cooked before consumption. At the same time, these processes destroy possible live trichinae in pork. Repeated rearrangement during curing of stocked meat cuts is important to eliminate pressed-out water.

Smoking, drying and ripening contribute to the development of very pleasant flavour, which is due to biochemical changes taking place in muscle and fatty tissue. First lipolysis takes place in which complex molecules of fat are broken down under the influence of enzymes, not only those normally present in fatty tissue, but also those of bacterial origin (especially *Micrococceae*). Second, oxidation is initiated by higher temperatures. Intensive oxidation of fat can cause undesirable rancidity. All these reactions taking place during processing develop very slowly, because the useful enzymes are enclosed in the cells. Drying and

ripening must therefore be long-term processes for the enzymes to be effective.

Raw Dry Hams

Dry hams are uncooked, cured, dried and usually smoked pork legs.

Raw material: The legs are cut from the pork sides and quickly chilled to an internal temperature of 2°C within 18 hours. Legs having blood clots, PSE or DFD muscles are not suitable. The minimum weight of a deboned leg is 5 kg.

Additives: A mixture of salt (10 kg), nitrate (400 g), sugar (500 g) and spices, usually black and white pepper, sage and ginger, is used for dry curing. Instead of salt and nitrate, the so-called nitrite salt can also be used. In some traditional methods only common salt is used.

Manufacturing: In the cold season and at high altitudes hams may be dried under natural conditions, according to the traditional method. Because of air purity and better circulation, nitrate is not usually used, so a larger quantity of coarse salt must be added, giving the finished product a more salty taste.

After overnight chilling, legs are cut off between the aitch bone and femur. Feet are removed but the skin is usually left on, but may be removed from the upper third of the leg to improve salt penetration. The legs are rubbed with the curing mix, arranged in a wooden cask placed in a cool place (about 0°C) and hand sprinkled with the same mix. Salting lasts about three weeks.

After a week they are salted separately and rearranged in another properly washed cask. After salting the legs are rinsed and the remaining salt is removed. They are tied and hung in a cool place for further drying

and ripening for at least five to six months. The windows and doors should occasionally be opened and closed and ventilation provided. Legs should be rearranged so that they are all uniformly dried.

Smoking can be applied in the processing of dry hams. Its purpose is to give the product a typical flavour, distinctive colour and to harden it. Smoking quality depends on many factors, but the most important are the smoke temperature at the product surface and air humidity. It is most important that the surface is dry enough before smoking starts. If smoking is a long-term process, drying occurs simultaneously but with a shorter process it must be done first in a drying room.

In raw dry ham production only cold-smoking is used (below 25°C). Smoke density and duration depends on local preferences. The industrial method uses special air-conditioned coolers, in which standardised conditions (temperature, relative humidity (RH), air ventilation and circulation) can be maintained all year round.

Faults may arise due to the use of poor-quality raw material, inadequate manufacturing, unclean containers, and/or non-hygienic conditions. The most common are:

- Crust on the upperface (3–5 mm thick), of hard consistency and darker colour which arises during smoking caused by low air humidity (below 65 percent) and/or very strong air circulation.
- Cracks around the head of the leg bone of varying size and depth, due to careless deboning and excessive drying.
- Insufficient drying of certain parts can appear in large hams, seen as lighter areas with a softer consistency. It is caused by improper processing (especially during drying and ripening), crust

formation (which prevents uniform drying of the inner parts), and/or insufficient air ventilation (especially when dealing with legs weighing more than 9 kg).

- Mould (yellowish or greenish) is caused by drying at high RH, due to poor ventilation and air circulation and/or mould contamination of equipment and workshop.
- Oversalty taste is the consequence of improper desalting.
- Rancidity arises from the oxidation of unsaturated fatty acids and in severe cases results in a yellow discoloration. High temperatures applied during smoking, drying and ripening, or poor-quality feed may be the cause.
- Spoilage within the product usually occurs around large blood vessels and is usually due to the raw material being contaminated during deboning, trimming and/or curing in non-hygienic containers. The characteristic brownish colour and unpleasant smell are caused by anaerobes.

Acarid findings show that products have not been properly protected against insects. If the process is carefully followed, the dry-cured ham is very tasty, nutritive and bacteriologically stable. Stored at room temperature, but not more than 30°C, and RH between 55–65 percent, the shelf-life should be four to six months.

Raw dry hams are ready for sale immediately after production and final control. They are sold as they are, or may be packed (half or small pieces) into plastic bags. All deboned meat pieces may also be sliced and packed under vacuum, in different consumer sizes, as trade demands. The most common use of dry hams and all

other uncooked meat products is in the form of very thin slices, for use in sandwiches or as starters. Bone-in products are used for preparing various cooked dishes.

In addition to dry hams, many other uncooked dry processed meat pieces may be manufactured from different primal cuts of pork carcasses and other species. All parts of a pork carcass may be used (ham, shoulder, loin, neck, back fat, jowl, head, tongue, ears, spare-rib, shank, feet, tail, bones etc.). A long shelf-life is achieved by a combination of long drycuring (more than two weeks) and long cold-smoking, with simultaneous drying and ripening. Dry-curing is always followed by repeated salt rubbing during weekly rearranging of meat pieces. Duration of salting or curing depends on size and on the coverage of skin or fatty and connective tissues.

All uncooked processed meat pieces must have: a regular shape without unnecessary cuts and rough spots; dry, clean surfaces; moderate cured salty taste and agreeable bouquet; and a water content in finished product not exceeding 30 percent. If the product has skin, it should be clean, light to dark gold-brownish colour, without bristles. "Country pork shoulder" is processed in a similar way to raw dry hams, though with a shorter production time. The combined period for curing and salt equalisation should be at least 25 days, and the total production time at least 50 days.

Dry neck can be made with or without the bones. If bone-in it is cut along the neck bones and first three vertebrae and the upper parts of the first three ribs (3 cm in length). Both types are dry-cured for a minimum of three weeks. Well-cured deboned necks can be filled firmly into fibrous casing or elastic nets. The thicker part must be tied and hung on a stick, and left dripping for five to six hours. When the surfaces are dry enough,

coldsmoking can start and should last three to four weeks.

Dry loin can also be made with or without the bones. In both cases it must be cut between the third back bone and last lumbar vertebrae, with the corresponding ribs to a width of 3 cm. The external layer of fatty tissue must not exceed 0.5 mm. If all muscles except the long back muscle are trimmed off it is called "dry real loin". Dry spare-ribs are the cured, smoked and dried lower half of the ribs, with muscles between them.

Dry head is the cured, smoked and dried half head of all kinds of small animal, totally deboned, without salivary and lymphatic glands and tonsils. Dry shanks and feet are well-cleaned, singed, cured, smoked and dried sheep, goat, deer and pig feet. Dry tail, usually cut off together with the aitch bone, is a cured, smoked and dried product.

Sheep, goat or small venison pastrami are cured, smoked and dried carcasses or sides, without the head and neck, either bone-in or partially deboned. In the first case, for better salt penetration, the largest muscles must be incised, the joints opened in the interior part, and the long bones broken longitudinally. In partially deboned products, all bones except the vertebrae are removed. In both cases, dry-curing agents are rubbed in and the carcasses or sides are spread in wide vats, to prevent creasing.

Curing lasts from three to four weeks, depending on the thickness. During that time the product is recured twice, with repeated rubbing. After curing it must be flushed, tied with many loops and hung on a stick for stretching by placing two rods longitudinally in the shoulder and ham. Smoking lasts for at least a month to

give a desirable gold-brownish colour and an attractive flavour.

Beef pastrami is dry-cured and smoked beef navel part or well-trimmed brisket. The raw material must be rubbed on both sides with a mix of nitrite salt and saltpeter and left in curing vats for two weeks. After seven days, the product must be repacked and, if necessary, some parts rubbed again. After curing residual salt is eliminated by washing and the product is hung for dripping. Smoking starts when the surfaces are dry enough, at 54°C, with light smoke, for three hours. The amount of smoke and the temperature are gradually raised until the inside temperature of 74°C is reached. The product is then removed from the smokehouse and hung at room temperature for a minimum of two hours before being placed in the cooler prior to sale.

Cooked Hams and Cured and Cooked Meat Pieces

The majority of this type of processed meat is fabricated from pork, but there are also certain cured and cooked beef products.

Cooked hams are made either from entire hams (pork leg muscles, with or without shank) or reconstituted from leg muscles or parts of them. As a rule, hams are produced as boneless, skinless, shankless and defatted products. Most often, they are packed in a can or plastic pouch sealed under vacuum. In both cases, pasteurisation (cooking at temperature lower than 100°C) is done in the final container in which they remain until slicing. Being perishable they must be kept under refrigeration. The exception is with small packages (lighter than 1.4 kg) of hams which can be produced as commercially sterile products.

Beef hams are made from meat from younger cattle and the same process is applied as for the manufacture of cooked hams.

Additives: Water, salt, sugar, phosphate, nitrite and sometimes salts of ascorbic acid and soy isolates are the basic ingredients of curing brine. The amount injected depends on product quality. Water used for preparing curing brine must meet the standards of potable water. All ingredients should be well chilled. Data presented in Tables 6 and 7 show that injecting 12, 31 or 36 percent curing brine of appropriate composition will give the desirable amount of salt (2.6 percent) and nitrites (0.016 percent) in the finished product. The amount of other additives may vary with local regulations.

Manufacturing: The highest standards of hygiene must be maintained at all stages. The processing steps are:

Brine injection: For small production one-needle brine injectors are sufficient. The modern method uses pickle injectors with a large number of needles, providing a more even distribution of the curing brine. Pressure during injection can be regulated, as well as the speed of the conveyor providing the material. These multi-needle injectors allow more brine to be injected into products than the traditional method.

The pressure of injection varies from 1 to 2 atm, depending on the number of needles used and the amount of brine to be injected. For high brine injection rates (20 percent or more) it is better to inject twice under low pressure than once under high pressure, to avoid the formation of "lakes" of brine in the muscles. The weight of meat must be checked before and after injecting. If the percentage of injected brine is less than that required, it can be made up by adding it in the massaging vat.

Table 6. Ingredients necessary for preparing curing brine for manufacturing regular hams (I), soy- and water-added hams (II) and ham imitations (III)

Ingredients	Quality of hams		
	I	II	III
		(%)	
Tap water	70.43	82.11	84.59
Nitrite salt	21.73	8.49	7.26
Dextrose	4.16	1.61	1.39
Phosphate	3.60	1.39	1.19
Soy isolate	-	6.40	5.55

Mechanical treatment of meat after brine injection has become a recommended process for larger-scale production, not only for cured entire meat pieces but also in the production of reconstituted smaller pieces. During mechanical treatment, muscular cells are ruptured so that myofibrillar proteins quickly come in contact with the brine and swell. Exudate which consists of cell juices, brine, meat particles and salt-soluble proteins acts like a "glue" to bind meat pieces together.

Processed ham can therefore be easily sliced without falling apart. The advantages of mechanical treatment are shorter curing time, better yield, less cooking loss, improved tenderness and better sliceability. Duration of the mechanical treatment depends on the machine and usually lasts from nine to 24 hours at 2-4°C.

Tumbling under vacuum is recommended to avoid foaming and to improve colour stability. Massaging vats have handles placed horizontally on the vertical axis propelled by the electrical engine which squeeze the larger pieces of meat. The duration of massaging, time intervals and total time are similar to tumbling. The use of a vacuum is not possible with these machines.

Table 7. Raw material composition of regular hams (I), soy-and water-added hams (II) and ham imitations (III)

Ingredients	Quality of hams		
	III	I	II
		(%)	
Whole muscles	85.00	66.00	0.00
Chopped muscles	3.00	3.00	64.00
Total meat	88.00	69.00	64.00
Water	8.45	25.45	30.45
Nitrite salt	2.62	2.62	2.62
Dextrose	0.50	0.50	0.50
Phosphate	0.43	0.43	0.43
Soy isolate	-	2.00	2.00
Total brine injected	12.00	31.00	36.00

Heat treatment (pasteurisation) of the product in plastic pouches, cans or ham boilers, is done either in an autoclave or a cooking vat in water at 80-85°C. Cooking lasts until the temperature at the geometrical centre (the coldest point of the product) reaches 70-75°C. Containers are cooled under running water until the temperature in the centre of the product falls to 35°C, when they are moved into coolers at 2-4°C.

Frequent faults committed during production

- Improper trimming of connective tissue which contracts during thermal treatment resulting in an uneven surface and holes in the cross-section.
- Bad sliceability of hams (pieces fall apart) is the result of insufficient mechanical treatment and/or insufficient exudate.

- Holes in the cross-section result from insufficient vacuum used during can stuffing.
- Uneven colour of slices due to incomplete trimming of PSE muscles whose pale colour persists to the finished product.
- Excessive cooked-out juice results from incorrect brine composition (insufficient salt or phosphate) or improper mechanical or heat treatment.
- Overcooking beyond the temperature required for pasteurisation increases the amount of cooked-out juices, and gives the product surface a softer consistency.
- Undercooking due to insufficient heat treatment is the greatest and most serious fault. The most important consequences are shorter shelf-life and/or rapid spoilage. Less important are harder consistency and uneven colour of slices.

Canned cooked hams should be kept at 5°C to give a shelf-life of six months. Thin slices of ham are used for sandwiches or as starters. Smaller slices are used for ham and eggs. Other products such as canned cured shoulders, loins, necks, etc. are manufactured in a similar way.

Comminution

Comminution is the mechanical process of reducing raw materials to small particles. The degree of comminution differs among various processed products and is often a unique characteristic of a particular product ranging from very coarsely comminuted, to finely comminuted, to form an emulsion.

Machines for comminuting: The range and quality of finished products prepared from comminuted meat

depend on the skill of personnel and the equipment available. A minimum layout should include grinder, cutter, emulsion mill and ice-maker. Machines must be designed for easy cleaning. All surfaces in contact with products must be smooth, free from pits, crevices and scales. Machines must be constructed either of stainless steel, or heat-resistant, non-toxic plastic material. All machines and tools must be carefully cleaned several times during the working day and disinfected at the end of the day.

Manufacturer's instructions about the use and the maintenance of the machines must be strictly followed. The grinder is usually the first machine used in the comminution of sausages. For non-emulsion-type sausages, grinding is often the only form of comminution. It is used to cut the raw material and thoroughly mix the ingredients. Meat is pushed along a worm-screw and then through perforated plates. The holes of the grinder plates vary both in size (2-30 mm) and shape. If the plates and knives are not kept in good condition, and particularly if they are not sharp, meat will be overheated, become greasy and lose its binding ability.

The cutter is the most important comminuting machine, for simultaneous comminution and mixing. Meat revolves in a bowl and passes through a set of knives mounted on a high-speed rotating arbor in a fixed position. The meat is guided toward the knives by a plough fixed inside the bowl. There are usually two speeds each for the bowl and the knives. The knives can differ in size and shape from rectangular to round. There can also be a special device for charging and discharging the bowl. To eliminate heating of the batter caused by friction, ice water is added. This is better than ice flakes alone.

To avoid excessive heating, properly sharpened knives must be used and the clearance between the knives and the bowl should not exceed 0.7 mm. A thermometer is mounted on the cover of the bowl to monitor the temperature of the meat batter. Modern cutters can operate under vacuum, which improves the colour and other properties of the finished meat products. Depending on the meat-particle size desired, it is possible to produce a satisfactory comminuted meat product using only the cutter.

For very fine products, such as frankfurter or bologna, it is often preferable to pass the emulsion obtained in the cutter through an emulsion mill. The emulsion mill is operated by one or more rotating knives, revolving at extremely high revolutions, pulling the sausage mixture through one or more plates. Emulsion temperature rises by up to 3°C on each pass through the emulsion mill. The ice-maker freezes water on the spot into ice flakes. There are many tools used in meat comminution.

- Trays, metallic or plastic, are used to keep, transport and weigh small quantities of the various raw materials and for washing dismantled parts of machines.
- Vats, metallic or plastic, are used to hold larger quantities of raw materials.
- Container trolleys are movable containers used to keep and transport raw materials from the cooler to the workshop, or between machines.
- Filling tables are metallic tables upon which the filled sausages run from the filler. They are made with raised rims, except under the filler.
- Sticks are wooden or preferably metallic equipment for hanging up linked sausages (individually or in

- links), or meat pieces, for dripping, smoking, heat processing and storage.
- Cages are metallic structures in which loaded sticks are transported for further processing (smoking and heat processing).
 - Balance and scales are used for weighing various raw materials, salt, curing agents and all additives. They are also used for checking product weight before and after each stage of processing to control weight loss.
 - Thermometers are used to check product temperature during comminution.

Comminution is a procedure which modifies the properties of fresh meat, so that the finished product consists of small meat and fatty pieces, or it can be finely subdivided to obtain a meat batter. This meat batter is a viscous mass, with many properties of an emulsion. A major problem in manufacturing emulsion-type sausages is the tendency of fat to be separated during heat treatment. The sausage batter, at least in part, is formed of a "fat/water emulsion" (meat emulsion or, better to say, dispersion), employing salt-soluble proteins of meat as emulsifying agents. Comminution, the basic method for sausage making can be: coarse, to produce non-emulsified sausages like salamis and summer sausages, or fine, to produce emulsified sausages like frankfurters, bologna, etc.

Coarse comminution is used to manufacture sausages with a coarse texture with small pieces of meat and fatty tissues visible. For Meat I and for Meat II a 15- to 25-mm grinder plate is used while trimmings and fatty tissues are passed through a 2- to 6-mm plate so that the connective tissues are less visible and more digestible.

Meat I and Meat II are passed through the grinder first, followed by the trimmings and finally the fatty tissues. This avoids fat separated from the fatty tissues greasing the surface of meat pieces thereby decreasing their binding ability. The meat should be well refrigerated (2–3°C) and firm, so that it will be cut cleanly by the grinder knives and not squeezed.

Correctly pre-ground meat is transferred into the mixer or mixed manually for formulation. Nitrite salt and phosphate are added and the mixing starts. All other non-meat components are added during mixing, finishing with ascorbic acid. When the mixture is uniform the sausage mixture is formed.

Fine comminution used to manufacture emulsion-type sausages is performed in a high-speed cutter. The knives must be kept thoroughly sharpened and properly adjusted to the bowl. During comminution bundles of fibres, myofibrils and filaments are separated and disrupted and the size of meat and fatty tissues is continuously reduced. The muscle tissue, having a stronger structure than fatty tissue, determines the total comminution time required. Heat produced during comminution helps the salt-soluble proteins to concentrate at the fatglobule surface and come in contact with water from the protein matrix.

Higher speeds produce a better distribution of fat due to the temperature rise but excessive temperatures can partially destroy the protein membrane which surrounds fat particles, and cause a breakdown of the sausage mixture. Unprotected melted fat migrates to the surface, forming easily visible fat pockets between the sausage surface and the casings. The melting point of fat is the parameter for determining the maximum temperature for the meat batter. Overcomminution can also provoke

breakdown. As the fat particle size continuously decreases, there is a proportional increase in the total surface of fat particles requiring proteins. Generally, as particle size decreases more meat and meat-extender proteins are required to form a heat-stable emulsion.

Frozen and chilled meat for different products: Frozen meat must be sliced in a frozen-meat slicer prior to grinding. The block of meat is placed upon the carriage and passed under a large knife which cuts the meat into large slices or smaller meat flakes. Frozen meat is not suitable for coarse comminuted sausages but may be used in manufacturing fine comminuted meat products. So that the optimal temperature (3–5°C) for extraction of salt-soluble proteins is reached, only water without ice is added in the cutter.

Some meat extender must be added to bind juices from the frozen meat which will be separated during heat treatment. Chilled meat is more suitable for both coarse and fine sausages as the meat batter can be more readily maintained at the optimal temperature. Another advantage is that neither a frozen-meat storage facility (minimum -18°C) nor a frozen-meat slicer is necessary.

Methods of addition of salt, additives and spices: The aim of using salt and/or nitrite salt in manufacturing comminuted meat is to separate the maximum quantity of salt-soluble proteins from the muscle cells. Optimum salt concentration for total extraction is 5–6 percent, and the optimum temperature is 3–5°C. Salt must be sprinkled on the pre-ground meat in the bowl as soon as possible. By mixing meat and salt at the slowest speed, salt starts to extract proteins from broken muscle cells. Half the ice water (1:1) is added to speed this process and control the temperature rise.

Additives contribute to improving and intensifying some properties of meat proteins, especially water-holding, water-binding and emulsifying capacities. In order to achieve this they are sprinkled on the meat after the salt has completed its effects, but always before adding fatty tissues. To achieve uniformly and well-flavoured comminuted meat products, spices must be properly sprinkled in the meat batter and are added after additives, but always before fatty tissue to avoid them sticking to it causing a non-uniform colour. All spices for sausage formulation should be weighed and mixed in a plastic bag before adding to the meat batter.

Hygienic aspects of comminuted meat: Comminuted meat is more highly perishable owing to the large surface area exposed to many sources of contamination, the availability of the meat juice, water and nutrients, and the distribution of surface flora during comminution. The flora count varies greatly, presumably reflecting the initial contamination. For example, the count in ground beef is usually less than in minced pork.

High counts will arise during comminution if the temperature of the sausage mixture is not properly controlled. It may however be preserved in different ways: adding salt and nitrite, smoking, heat treatment, and adequate storage. The preservative effect of salt is due to its capacity to lower water activity to a level that inhibits bacterial growth. For a longer shelf-life other preservative methods must be used such as the addition of nitrite which has a marked bacteriostatic effect.

If the sausage mixture is kept at a relatively high temperature (above 20°C) before it is filled into casings, vegetative bacteria will grow and cause deterioration. In order to kill most micro-organisms present, emulsion-type sausages must be heat-treated to an internal

temperature of 72–75°C. The product shelf-life is thereby significantly extended. The product must be quickly chilled after heat treatment, in order to prevent growth of any surviving flora. After the final inspection it is ready for sale. Finished products must not come into contact with the floor or any other contaminated materials, especially raw meat or natural casings.

Contamination During Comminution

The basic objective of meat comminution is to manufacture sausages of standard quality with a desirable hygienic level, and an acceptable shelf-life. For this reason, during comminution all improper handling which can promote growth of micro-organisms must be eliminated. The meat products are not only highly perishable, but may also become the source of foodborne diseases. Following are some sources of contamination during comminution:

Unclean machines. Meat batter and sausage mixture represent very good nutritive media for rapid growth of micro-organisms, owing to the presence of the soluble nutrients. If any interruption in production is greater than half an hour the machine must be emptied, the sausage mixture placed in the cooler, and the machine immediately washed. Failure to do so will lead to heavy contamination of the next batch. The contamination will be even more serious if residual material stays in unclean machines overnight or even during the weekend.

To eliminate these hazards the machine must be washed immediately after use with hot water. The best method of washing for machines, containers and walls and floors is with a special cleaning machine. When attached to the water supply the machine can increase the water pressure tenfold to make cleaning very effective.

Liquid disinfectant may also be added. Hot water (minimum 83°C) gives the best results.

During dismantling of any machine, either for daily washing or routine control of cleanliness, dismantled pieces must not be placed on the floor. They should be put in a plastic (not metallic) tray or vat and after washing hung on a rack, for draining overnight. The next day their cleanliness and sharpness must be checked before use. Water remaining after cleaning must be eliminated before leaving the workshop.

Unhygienic handling: There are many manual operations in a nonautomated production line for comminuted sausages. Unhygienic handling can provoke rapid bacterial growth, which will persist even after hightemperature heat treatment, resulting in a shorter shelf-life. Meat trays, other tools, plastic aprons etc. must never be washed on the floor. Any material falling on the floor must not be reused in further processing. All dirty and contaminated material must be placed in a special watertight non-corrosive bucket, with a lid fastener, to prevent access to unauthorised persons and clearly marked in large red letters "condemned".

Animals Symptoms of Disease

Effective control of a new disease in animals required government to identify its nature and extent as quickly as possible. Bearing in mind that animals are raised on thousands of separately owned holdings, often in remote areas, this is no easy task.

The Animal Health Act 1981

This Animal Health Act consolidated earlier animal health legislation and applied to England, Wales and Scotland. Its equivalent in Northern Ireland was the Diseases of Animals (Northern Ireland) Order 1981, which explicitly covered a larger number of diseases but which was essentially similar as far as BSE was concerned and is therefore not described separately. The Act gave Ministers wide Order-making powers to prevent the spread of disease. There was no requirement to consult before making such Orders.

The Act defined 'disease' to mean, unless the context required otherwise, cattle plague, pleuro-pneumonia, foot and mouth disease, sheep-pox, sheep scab, or swine fever, but it specifically allowed for the definition of 'disease' to be extended to include any other animal disease. The powers granted by the Act were exercisable

by the Minister of Agriculture for the whole of Great Britain, by the Minister of Agriculture, the Secretary of State for Scotland and the Secretary of State for Wales acting jointly, or by 'the appropriate Minister' which meant the Minister of Agriculture in England and the appropriate Secretary of State in either Scotland or Wales.

The Animal Health Act 1981 was not restricted to the prevention of disease in animals. It also empowered Ministers to designate as a zoonosis any disease or organism carried in animals which in their opinion constituted a risk to humans; the Act could then be used to make Orders for the purpose of preventing the spread of disease between animals and between animals and humans. Many of these Order-making powers derived from earlier legislation which had been deployed against diseases such as brucellosis and tuberculosis (TB) in cattle, foot and mouth disease, or non-cattle infections such as salmonella in eggs and poultry, and swine fever.

Orders continued to be made under the Act against these and other diseases both before and after 1986. A particular feature of the Animal Health Act 1981 was that it offered a quick and simple process for the introduction of secondary legislation.

Statutory instruments under the Animal Health Act are relatively easy to make. They are laid before Parliament and have no Parliamentary procedure. On that particular Act it was not difficult to make statutory instruments, unlike the Food Act which was very difficult. Almost all the Orders made under this Act could be brought into effect by non-parliamentary procedure. This consisted simply of publishing the Order in the official government publications, the London Gazette and the Edinburgh Gazette, and by requiring local authorities notified by the Minister to publish the Order in a

newspaper circulating in their areas, or publicise it by some other means required by the Minister.

An exception to this was an Order made under section 32, which concerned the slaughter of and compensation for animals with diseases other than those listed in section 31. Orders made under section 32 were subject to the negative resolution procedure. The Animal Health Act was also unusual in that section 60 gave the police force of each police area responsibility for its execution and enforcement. But in addition 'inspectors' were given wide enforcement powers by section 63 of the Act.

Inspectors were appointed on the one hand by the Minister, in which case their powers extended throughout Great Britain or the area to which they were appointed; and on the other, by each local authority, which was required by section 52 to appoint as many inspectors as it thought necessary for the execution and enforcement of the Act. A farmer faced with a condition that he did not recognise or that did not respond to a standard treatment would contact a private veterinary surgeon.

The veterinarian, if unable to treat or diagnose the condition, would normally seek assistance from the nearest MAFF Veterinary Investigation Centre (VIC). As part of the State Veterinary Service (SVS) the VIC had access to research information and knowledge from its own databases and those of other VICs across the country, which together formed the Veterinary Investigation Service, and also from MAFF's Central Veterinary Laboratory (CVL). The VICs recorded such voluntary submissions of information from farmers, made through their vets, on the Veterinary Investigation Diagnosis Analysis (VIDA) system, thus creating a database of disease knowledge.

Hence, the initial recognition of a new disease remained an entirely voluntary matter for farmers and private vets until it reached the VIDA system and could be identified in an orderly and structured way. In Scotland, a similar service was offered by the Scottish Agricultural Colleges, which were independent of MAFF. For known diseases, explicit control measures were to be applied from the moment the disease was recognised. Section 15(1) of the Animal Health Act 1981 required anyone with an animal affected by disease to keep it separate from unaffected animals and to give notice to the police that it was suffering from a disease, with all due speed. Section 88(1) of the Act stated that

... unless the context otherwise requires, 'disease' means cattle plague, pleuro-pneumonia, foot-and-mouth disease, sheep-pox, sheep scab or swine fever subject to section 88(2), which empowered Ministers to extend, by Order, this definition of 'disease' to comprise 'any other disease of animals'.

Once a new disease was recognised, the Minister could make an Order under section 15 requiring the separation and notification of any animal affected by that particular disease. This became the responsibility of anyone possessing such an animal or having charge of it, thus including both the farmer and the private vet, as well as anyone transporting or selling the animal on behalf of the owner.

Failure to separate and notify was an offence. An Order made under this section of the Act usually required that the Divisional Veterinary Officer of MAFF be notified. It was also usual for an Order to require that an affected animal was detained where it was, whether alive or as a carcass, until a veterinary inspector had examined it. Although, at that time and before, the EC could require notification of animal diseases in the

Member States by Directive 82/894/EEC, that power was not used in making BSE notifiable.

Notifiable diseases were monitored as part of an international effort to establish their extent and spread so as to assist in the control and eradication of animal diseases. However, the range of available control measures was wide and, as with notification, the appropriate powers were usually applied by Order to a particular disease from the available 'menu' within the Animal Health Act itself, depending upon the nature of the disease concerned.

Consequential action may involve the slaughter of a single animal (a reactor) with further testing of the herd at a later date after a period in which movements out of the herd may be restricted. There will obviously be additional investigations in an attempt to determine the source of infection. Brucellosis and tuberculosis are two diseases that are dealt with by such an approach. Alternatively the nature of the disease may demand more drastic action in order to rapidly break a cycle of infection of other herds. This applies to exotic diseases such as foot and mouth disease, classical swine fever, avian influenza, fowl pest.

In such instances confirmation of disease would result in rapid whole herd/flock slaughter and the enforcement of standstill orders on farms within a specified radius of the affected farm. Because live infected animals excrete large quantities of virus in such instances, with considerable potential for spread by air as well as through movements of animals, humans and products, immediate draconian action is both effective and justified.

There were specific legislative provisions for control measures. Firstly, section 63 of the Act permitted the inspection of premises in almost any circumstances to

establish the extent of disease. Inspectors, who could be appointed by the Minister or by the local authority, could enter any land, building or place where they suspected that:

- i. the carcass of a diseased or suspected animal was kept or had been kept or disposed of in any manner;
- ii. there was any pen, place, vehicle or thing in respect of which anyone had failed to comply with the Act or an Order;
- iii. the Act or an Order had not been complied with.

Then, depending on the terms of any Order made under this section, an inspector could examine any carcass or animal, make any tests on animals he considered necessary, and mark those animals for identification purposes. This power enabled the authorities to check the true extent of the disease where owners might, for whatever reason, be reluctant to give notification of diseased animals. It therefore permitted more effective and complete control of infected animals by enabling more precise knowledge to be obtained. Secondly, movement generally could be controlled by Orders made under section 8 of the Act, and movement of diseased or suspected animals in particular was controlled under section 25. These powers enabled Ministers to:

- i. prescribe and regulate animal markings;
- ii. prohibit and regulate animal movement, including the removal of carcasses, fodder, litter and dung, and the isolation of newly purchased animals;
- iii. prescribe and regulate the issue and production of movement licences; and
- iv. prohibit and regulate the holding of markets, fairs, exhibitions and animal sales.

More specific Orders could be made under sections 9 to 11 to prohibit animal conveyance by particular means, where this could introduce or spread disease in Great Britain, and to regulate the export to Member States of the EC of animals or carcasses, whether or not subject to licensing arrangements. The above powers, which provided a 'menu' of options, were usually implemented by veterinary inspectors' being granted the power to serve notices on particular owners regarding individual diseased animals or entire herds, or by the publication of area-wide or national restrictions on movement. This could be further reinforced by the use of the power to mark and hence identify suspect animals and by the use of movement licences or permits, which could identify and control the movement of the animals in question by reference to the marking system.

Thirdly, section 7 of the Act empowered Ministers to make Orders prescribing and regulating the cleansing and disinfection of any places used for animals, including any vehicles, vessels or aircraft, and for the disinfection of the clothes of anyone in contact with diseased or suspect animals. This power had been widely used before 1986 in dealing with diseases which were particularly contagious and easily transmitted and spread by contact. In this respect, they complemented the controls requiring separation of diseased animals and those prohibiting or regulating movement.

Where outbreaks of disease were confined to relatively limited areas, sections 17 and 23 of the Act gave Ministers powers to declare that places or areas were infected with that particular disease. Within these infected areas or places, Ministers could make further Orders prohibiting or regulating movement of animals or people, requiring the isolation or separation of animals,

prohibiting the removal of carcasses, fodder, dung, utensils and equipment from such areas or the destruction, burial, disposal or treatment of those items, and prescribing and regulating cleansing and disinfection, including clothes of people in those areas.

The risk to human health from the transmission of animal diseases was recognised by section 29 of the 1981 Act, which enabled the Ministers to make Orders designating as a zoonosis any disease or organism which carried such a risk. Further Orders could be made under this section to apply the provisions of the Act to the zoonosis and to require anyone who knew, suspected, or had information that any animal was affected by a zoonosis to give information to that effect to persons and in the form specified by the Order.

Section 30 of the Act enabled a veterinary inspector who had reason to believe that an animal known or suspected of carrying a zoonosis had been on any land, to enter that land and make tests and take samples to establish whether this was the case. This complemented the general entry powers of section 63 expressly in relation to zoonoses. Further general powers for the purpose of preventing the spread of disease were contained in section 16. Under these, the Ministers could cause to be treated with vaccine or serum any animal or bird which had been in contact with a diseased animal or bird, or which appeared to have been in any way exposed to infection, or which was in an infected area.

In order to fund the potentially very expensive cost of disease control, section 3 granted the power, subject to Treasury approval, to spend such sums as the Ministers thought fit, with the aim of eradicating diseases of animals in Great Britain. Section 3(2) enabled Ministers to authorise any veterinary inspector or other officer of the

Ministry to inspect animals in order to obtain information for disease eradication. Effective control of animal disease required a means of identifying individual animals so that their movements could be traced.

The Tuberculosis (England and Wales) Order 1984, made under the Animal Health Act, required owners of bovine animals to mark or identify them in a manner approved by the appropriate Minister and maintain such marks so that they were clearly identifiable. This requirement did not apply to an animal less than 14 days old that was not removed, or was removed only to a slaughterhouse, within that 14-day period. The Movement of Animals (Records) Order 1960 required all animal movements to be formally recorded, with the exception of:

- i. those between different parts of the same premises;
- ii. movements to or from any premises for feeding, watering or milking purposes, and returns to the same premises, provided that the return took place within 24 hours of the first movement;
- iii. movements of pigs (these were subject to different legislation); and
- iv. movements to or from lairs, wharves or approved landing places used for imported animals.

These recording requirements did not apply to persons acting as market authorities or auctioneers at any market, saleyard, fairground or other premises, or to persons responsible for holding exhibitions of animals, or to anyone carrying on the business of transporting goods by rail, road, air or water when they were moving animals in the course of that business on behalf of other persons.

The measures discussed so far deal mainly with circumstances where separation, isolation and treatment

offered some prospect of saving animals affected by disease. But in many cases, no such treatment was available or effective at a cost that would be economic. Moreover, some diseases were recognised to be so contagious that it was impossible in practice to provide the necessary isolation and separation, not just of the animals involved, but of the humans tending or treating them. In these cases slaughter, of the affected animals or of entire herds, was the only option for effective disease control.

Sections 31 and 32 and schedule 3 of the Animal Health Act gave the Minister power to cause the slaughter of any animal affected by specified diseases, or by any disease to which he directed that the section should apply, or of any animal suspected of those diseases, or which had been in contact with, or in a place occupied by, diseased or suspected animals. Section 32(4) required the Minister to pay compensation for animals slaughtered under these provisions, according to scales prescribed by Orders made by him with Treasury approval. Such an Order, exceptionally for the Animal Health Act, had to be laid before both Houses of Parliament and was subject to the negative resolution procedure.

Further powers relating to slaughter and compensation were contained in section 33, which enabled the Minister to employ and pay additional inspectors, valuers and other persons in order to execute those responsibilities, and to hold animals intended for slaughter for observation and treatment. Under section 34(2), the carcasses of all animals slaughtered under those provisions belonged to the Minister, and could be buried, destroyed or disposed of as he directed.

In the case of burial, the Minister could use any ground belonging to the owner of the slaughtered animal for that purpose. Finally, the Minister could make Orders under section 34(7) prescribing the way in which the value of these slaughtered animals was to be calculated, for regulating applications for and the mode of compensation, and for prescribing and regulating the destruction, burial, disposal or treatment of carcasses.

If Ministers considered it expedient to prevent the spread of a disease specified in sections 31 and 32, they could make an Order under section 35 of the Act providing for the seizure of anything, animate or inanimate, that in their view might carry or transmit disease and for its destruction, burial, disposal or treatment. This included animal carcasses, but not live animals. Section 35 also enabled Orders to be made to prescribe and regulate the destruction, burial, treatment and disposal of carcasses and anything else seized, and to prohibit or regulate the digging up of buried carcasses.

It was an offence to throw or place the carcass of an animal which had died of disease or which had been slaughtered as diseased or suspected, into any river, canal, waterway or the sea, or to dig up a carcass buried by a direction of the Minister or a local authority. Compensation for the seizure of carcasses and for anything else seized under these powers was payable by the Minister subject to conditions similar to those relating to the slaughter and compensation provisions.

The duty of executing and enforcing the provisions of the Animal Health Act and of every Order of the Minister was placed on the police force of each police area by section 60(1). Powers of detention, search, entry and apprehension were given to constables for this purpose. But section 62 gave the same powers (apart from those

relating to rabies) to 'inspectors', and section 52 required every local authority to appoint as many inspectors and other officers as it thought necessary to execute and enforce the Act. In practice, the inspectors concerned would have been the trading standards officers employed by those authorities.

However, section 63(8) in turn gave an 'inspector of the Minister' the same powers as those of inspectors, while subsection (9) granted the Minister's inspectors the additional power of entry to land or buildings where they thought animals had been held, to ascertain whether disease was present, or had been present. Section 65 gave the Minister's inspector the further additional power to detain vessels, vehicles or aircraft. Thus, the widest and most effective powers were given to inspectors appointed by the Minister of Agriculture, notwithstanding the apparent similarity of the responsibilities placed on the police and local authorities.

In practice, these enforcement powers were executed by Veterinary Officers (VOs) of the Veterinary Field Service (VFS), the statutory arm of the State Veterinary Service. The VFS dealt with notifiable diseases, the protection of animal welfare, facilitating the export of animals and animal products through the control of notifiable disease and the provision of export certification verifying the status of the exported commodity, as well as meat hygiene and slaughterhouse inspection duties.

In 1986, the condition of meat entering the human food chain was regulated in three ways. Firstly, it was an offence for slaughtering to take place on any premises unless these met certain standards of hygiene and had been licensed. Secondly, animals and carcasses whose physical condition did not meet certain standards could not be admitted to a slaughterhouse. Thirdly, the

carcasses of slaughtered animals had to be inspected and passed fit for human consumption.

In 1986, slaughterhouses and slaughtering were regulated by the Slaughterhouses Act 1974. Hygiene in relation to the sale of food for human consumption and the importation, preparation, transport, storage, packaging wrapping, exposure for sale, service or delivery of food intended for sale or sold for human consumption was regulated by the Food Act 1984. Determination of whether meat was fit for human consumption and the treatment of unfit meat were regulated by the Meat Inspection Regulations 1963, the Slaughterhouses (Hygiene) Regulations 1977, the Fresh Meat Export (Hygiene and Inspection) Regulations 1981, and the Meat (Sterilisation and Staining) Regulations 1982. Parts I, II and IV of the Food Act 1984 were repealed by the Food Safety Act 1990.

Packaging and Labelling

The following Acts and Regulations are applicable to the packaging and labelling of meat products either prepared in registered establishments or imported:

- The Meat Inspection Act and Regulations.
- The Consumer Packaging and Labelling Act and Regulations.
- The Food and Drugs Act and Regulations.
- The Canada Agricultural Products Act and Regulations made thereunder.

The use of the Meat Inspection Legend is only permitted in connection with edible meat products in a registered establishment. Note that a meat product prepared as an edible meat product for export, that would not qualify as edible in Canada, may be labelled with the Meat Inspection Legend, provided that the container is marked "For Export". The Meat Inspection Legend shall not be used on inedible meat products or on containers of inedible meat products. The Meat Inspection Legend may be used:

- as part of a label applied to edible meat products
- for direct application to carcasses, sides, quarters, primal cuts, sub-primal cuts and organs

- for direct application to a natural casing containing a meat product.

Types of Containers

Basically, there are two types of containers: retail containers and non-retail containers.

1. Retail containers:

- Bags
- Casings (natural and artificial)
- Cartons
- Mono-cups
- Folders
- Glass jars
- Pouches
- Cans
- Wraps

2. Non-retail containers:

- Tanker Trucks
- Combo bins
- Tanks
- Bags, including stockinettes
- Wraps
- Cartons
- Cans

Types of Labels

The Packaging, Labelling and Evaluation Unit

distinguishes the following types of labels and refers to them under the following codes:

- A - Artificial casing
- B - Printed bag
- BL - Pressure-sensitive label for bag
- C - Individual carton and mono-cup lid
- CB - Combo bins
- D - Stencilled product description, (pail, barrel head, barrel and drum)
- DC - Display carton
- EC - Edible casing
- F - Bacon folder or wallet
- G - Paper label for glass jar
- HB - Hessian bag
- HL - Header label (hanging)
- I - Insert label
- K - Kemex label
- L - Paper label
- M - Breast tag; clip for bag or casing
- P - Pouch, film, foil or paper
- PB - Poultry bag
- PL - Placard label for freight car, tank car or truck
- PS - Pressure-sensitive label for consumer sized products
- RS - Stamp, stencil or pressure-sensitive label for use with shipping container
- S - Shipping container

- SB - Sleeve printed band
- SL - Label for shipping container
- SV - Sealed vehicle
- T - Lithographed can
- W - Wrap, cello, foil or paper
- X - Shipping tag
- Y - Stockinette
- Z - Tag for sausage in natural casing
- Only pressure sensitive labels used for sealing containers of unstamped meat products must be tamper evident. Tamper evident means that the pressure sensitive label cannot be removed in its entirety or re-used without obvious evidence after it has been applied.
- All other pressure - sensitive labels need not be tamper evident, but must stick securely to the shipping cartons or immediate containers.

Package Design Guidelines For Vexar Netting

(a) General

- Opaque bags, casings or wrappings of any colour are acceptable, including for poultry carcasses.
- Tinted transparent and semi-transparent bags, wrappings or films are permitted under certain conditions.
- Vexar netting, or any simulation thereof, must be of significantly contrasting colour to the product it is covering.

The wrappings shall not be of such colour, design or kind as to be misleading with respect to colour, quality or kind

of product to which they are applied. Transparent or semi-transparent wrappings for articles such as sliced bacon or fresh (uncooked) meat food products shall not bear lines or other designs of red or other colour which give a false impression of leanness of the product. Transparent or semi-transparent wrappings, casings or bags for use in packaging cured, cured and smoked, or cured and cooked sausage products, and sliced ready-to-eat meat food products may not bear red designs which would unduly enhance the appearance of the product.

In the case of packages of bacon slices (belly or side), the window area on the package must be large enough to expose at least (66%) of the bacon strip length, as well as the complete width of the bacon strip.

Use of Coloured Containers

(i) Prepackaged meat products:

- meat products intended to be sold directly to the consumer shall not be packaged in coloured transparent or semi-transparent containers unless:
 - a declaration attesting that the container is coloured, appears: (1) on the label in close proximity to the product name (e.g. “Beef sausage in coloured casing”); or (2) on the container printed in a repeated manner.

and

- a cross section of the meat product is visible through a clear colourless film.

(ii) Non-prepackaged meat products:

- this category of meat products refers to those meat products that are not intended to be sold directly to

the consumer in their original container but require slicing and cutting by the retailer before being offered for sale. Such products are not required to bear special markings/declaration or to show a clear cut surface. This would include meat products sold to deli outlets, hotels and restaurants. There is no weight restriction for these products.

Coloured transparent or semi-transparent containers that may give a false impression of the true colour of the product will be identified in the "Reference Listing of Accepted Materials and Equipment".

Requirements of Label Registration

(a) From Canadian registered establishments:

- (i) all labels intended for immediate containers of prepared edible meat products for domestic sale, except
 - meat products exempted under paragraph 3(1)(i) of the Meat Inspection Regulations,
 - salted Kosher meat, and
 - salted casings; and
- (ii) all labels for meat products with a claim in regard to the term "organic".

(b) From foreign establishments authorised to export meat products to Canada:

- (i) same as from Canadian registered establishment; and
- (ii) all labels intended for immediate containers of non prepared edible meat products intended to be sold directly to consumers at the retail level in Canada.

Submission of labels for registration

It is strongly recommended that before a label or a sketch of a label is submitted to the Packaging, Labelling and Evaluation Unit for registration, the operator presents the proposed label, together with a completed application form AGR 1478 and recipe, to the Inspector in Charge of the registered establishment. When consulted, the Inspector in Charge should review the label and the recipe and recommend it for registration by initialling form AGR 1478 if, in his opinion, the label is satisfactory.

The Inspector in Charge will act as advisor to the operator and his comments should be included on the application form. The preliminary review by the Inspector in Charge is intended as a screening process and also serves to keep the Inspector in Charge informed of the operator's intentions to develop a new product or of a forthcoming label change. Upon receipt of a proof of registration for a label, the inspector in charge shall forward any objection or comment that he has concerning that label to the Senior Coordinator, Packaging, Labelling and Evaluation with a copy of the correspondence to his Regional Director.

The following number of copies of sketch labels and application forms are required by the Packaging, Labelling and Evaluation Unit:

- All meat products, (except when generically labelled)
- 3 copies of the label sketch (proof)
- 5 copies of the application form

The Packaging, Labelling and Evaluation Unit issues a registration number at the time the proof is registered. The operator may then proceed to have the labels printed.

The Inspector in Charge should release the final labels for use, provided they have been prepared as per registration instruction. Any final label which is not in accordance with the registration shall be submitted to the Packaging, Labelling and Evaluation Unit for decision.

The operator shall submit one photocopy of the proof registration, together with a final printed label to the Packaging, Labelling and Evaluation Unit, for record purposes. If the final printed label is not submitted to the Packaging, Labelling and Evaluation Unit within a period of 120 days following proof registration, then the label registration lapses automatically.

The operator shall provide the Inspector in Charge with a final label for his file and at this point, the Inspector in Charge should make certain that the operator has, in fact, sent the final label to the Packaging, Labelling and Evaluation Unit. Copies of the application form are not provided in quantity to operators. An operator will have to reproduce the extra copies.

Generic Labelling

(a) Detailed Label Application Procedure

- (i) 5 copies of the application form CFIA 1478.
- (ii) 2 copies of the product formula if applicable, typed on company letterhead or computer printout signed by a company representative.
- (iii) 5 copies of form CFIA 2623 identifying the different:
 - brand names (if more than one),
 - weights,
 - company or first dealer's names and addresses,

- refrigeration statement,
 - number of portions.
- (iv) For each application 3 copies of the label proof are required for label registration. 1 copy of final label for each label submitted and registered. We also require one final label bearing modifications as indicated on form CFIA 2623, e.g. one label for each brand name.

Operators may obtain one registration number for products having different: brand names net weight storage instructions number of portions company names or first dealers provided the ingredients and the method of preparation are the same. Once a registration number is given to a label, it is not necessary to make a new submission for changes in any of the five above-mentioned parameters. It is only necessary for the operator to send an updated label for our files together with a photocopy of application forms indicating the registration as a reference. In all cases, a maximum of 99 entries per registration number will be permitted due to limitations in our present data processing system. Only one type of label per application is allowed (cry-o-vac bag, combo bins, pails, shipping cartons, bacon folders, casing, etc.).

- (b) The following need not be submitted for registration:
- meat cut qualifiers not appearing in Meat Lexicon and in accordance with Industry Canada Communique 16;
 - medals (silver, bronze, etc.);
 - ribbons - red, blue, etc.;
 - portion controlled weight ranges;

- client's name in addition to the packer's or first dealer's name and address.

Generic labels must contain all the mandatory information as prescribed in paragraph 94(1)(a) of the Meat Inspection Regulations, 1990. Any changes not covered by (b), should be submitted to the Process and Recipe (Labels) Unit for registration.

The procedures for the registration of promotional labels have been divided into two groups:

- a promotional label for a meat product on which a change in the mandatory information has been made, bearing a statement such as "new", "improved", "leaner", "fortified", "less fat", "no filler"... must be submitted to the Process and Recipe (Labels) Unit for registration, as outlined under 7.5; and
- a promotional label which highlights a contest, give-away, refund, "coupon inside" does not have to be submitted for registration. This only applies to a label that has received a registration number and that had no change made to the mandatory information. A sample of such a label, together with a reference to the original registration number, shall be submitted to the Process and Recipe (Labels) Unit, and the Inspector in charge for record purposes only.

Flashes are permitted provided they do not obliterate any of the mandatory information. Depending upon the statement that is highlighted, the same procedures as for (a) and (b) apply.

The submission and registration procedures for foreign labels, from firms approved for export of meat products to Canada, are basically the same as those

described in 7.5.2. However, the following procedures differ:

- form AGR 1419 shall be used for submissions, instead of AGR 1478.
- no recommendation from the Inspector-in-Charge is required.
- the Process and Recipe (Labels) Unit deals directly with the firm or the firm's representative.
- the Meat Inspection Authority of a foreign country is responsible to see that labels used for export of meat products to Canada comply with proof registrations received from the Process and Recipe (Labels) Unit.

In the case of a prepared meat product, the product formulation and the method of preparation shall be submitted in duplicate on company letterhead, signed and dated by a company official. All modifications and notes added afterwards to these documents will have to be clearly identified. One of the following two methods can be used to indicate that the changes were authorised:

- a company official initials the modifications and signs the document (print name, title and date); or
- the authorised agent of the company initials the changes and signs the document, and the following declaration is printed on the document: "discussed with (name and title of the company official, date)".

The formulation must be complete and the method of preparation shall be outlined in detail. Total protein and meat product protein percentages shall be provided for standardised meat products for which minimum percentages are prescribed. If found acceptable, one copy will be kept on file in Ottawa and the other will be

stamped with an official stamp and returned to the applicant. The list of ingredients and the method of preparation on that copy are considered as official. When an inspector wishes to confirm a formulation, management must produce the officially stamped copy.

When edible meat products are labelled for retail sale, the mandatory requirement must appear in both official languages on the container. The following information is generally referred to as being mandatory:

- the identity of the meat product;
- the net quantity of the meat product (except in the case of random (catch) weight products);
- the list of ingredients (where applicable);
- the name and address of the registered establishment where the meat product was produced or labelled or of the person for whom the meat product was produced or labelled, preceded by the words “Prepared for” and “Préparé pour”;
- the Meat Inspection Legend;
- the storage instructions; and, where applicable:
- the durable shelf life statement;
- the production date or the identification code of production lot.

The mandatory requirements are dealt with in more detail below and in the Meat Inspection Regulations, 1990.

Identity of the Meat Product

The common name is the name under which a meat product is generally known. Meat products for which a compositional standard is prescribed in the Meat

Inspection Regulations, 1990, shall be marked with that name. In the labelling of ground meat, only the following four designations are permitted, depending on the fat content: regular ground "meat" (max. 30% fat), medium ground "meat" (max. 23% fat), lean ground "meat" (max. 17% fat) and extra-lean ground "meat" (max. 10% fat), the term "meat" being replaced by the name of the animal specie (example, regular ground beef).

In the case of a beef carcass, a complete side, a hind quarter, a front quarter, a primal cut or a sub-primal cut, the product must be identified according to the specifications prescribed in the Livestock Carcass Grading Regulations. Where a non-meat product ingredient such as fruit, vegetables, nuts, cheese, macaroni, pickles or olives is added to a standardised meat product, the name of that non-meat product ingredient must be included in the name of the meat product.

If a meat product, consisting of meat, meat by-products, mechanically separated meat, or a combination of these meat ingredients, derived from more than one animal species, is referred to as being derived from an animal species, then all the animal species from which the meat products are derived must be identified. Instead of adding up to 20% of boneless skinless meat in pieces weighing 25 g or more, the processor may opt to inject up to 15% of ground or emulsified meat trimmings.

A "solid cut meat product" is an edible meat product consisting of either a solid piece of meat or containing at least 80% of boneless skinless meat in pieces weighing 25 g or more. Such a meat product may be identified by its common name (ex. Boneless Ham) without further qualifications (ex. chopped and formed).

The pieces of meat of 25g or more are calculated on the basis of the weight of raw meat, before any other

ingredient is added. It is understood that the processes subsequently used (e.g. injection of brine, massaging and tumbling) result in the release of fine particles of meat. This is a normal reaction. However, to maintain its status of a "solid cut meat product" the process must ensure that the final product respects the proportion and size of pieces of meat as established in the raw meat state.

The use of superlatives such as "First Choice" or "Best Quality" in the name of a meat product is only acceptable if the superlative is preceded by the name of the firm manufacturing the meat product or by the name of the firm for which a meat product is prepared.

Special attention must be paid to the origin of natural casings used as wrapping and/or as rework material. If the natural casing used is of a different animal species than that of the meat ingredients used in the sausage, the natural casing must be declared. The declaration of natural casing may either be added at the end of the list of ingredients, or, if the natural casing is used to wrap the product, in the name of the product. If an animal species is included in the product's name and the product's casing originates from another species, the natural casing must be declared in the product's name.

- i) Declaration of the natural casing in the list of ingredients: The declaration of the natural casing is not required when it is derived from an animal species that is used as a meat ingredient in the product.
- ii) Declaration of the natural casing with the name of the product: The declaration of the natural casing with the name of the product is allowed only when the product is stuffed in the declared natural casing. When the natural casing is associated with

the name of the product it is not required to declare it at the end of the ingredient list.

The declaration of the casing must appear as part of the name of the product when:

- animal species (re. meat ingredients) are declared in the product name, and
- the casing is of a different animal species than the ones declared.

Examples: Product name “Beef Sausage in pork natural casing”, “100% Beef sausage in lamb natural casing”, “Beef and Pork Sausage in lamb natural casing”

Descriptions such as “100% Beef Sausage”, “All Beef sausage”, or “Pure Pork Sausage” are acceptable, provided the meat product ingredients have been derived exclusively from the animal species indicated. In the case of meat patties, such modifiers are acceptable for use in the product name, provided that:

- as with sausages, the meat product ingredients are derived exclusively from animal species indicated, and
- the qualifying phrase “with seasoning added” appears in close proximity to the product name.

Enzyme

Meat products which are tenderised with a proteolytic enzyme and are being packaged for retail sale or for being sold directly to HRI, shall be described as “Tenderised (name of the meat product)”. The enzyme(s) that was used does not need to be part of the name of the product but must appear in the list of ingredients. Meat products which are tenderised with a proteolytic enzyme and are being packaged in bulk containers shall be

described as "(name of the meat product) tenderised with (naming the proteolytic enzyme or enzymes)". The enzyme that was used also must appear in the list of ingredients on the bulk container.

Flavour

When a flavour is added to a meat product, it is not necessary to reflect this in the product's description (i.e. the product's name). However, flavours shall be shown in the list of ingredients as "flavour" or "artificial flavour", as applicable. Generally, all the components of flavours need not be declared in the list of ingredients but certain exceptions apply. The added flavour preparation(s) (i.e. actual flavouring agents and carrier agent(s)) shall not exceed 1% of the total product by weight.

Common Name of Sausages

Common name descriptions of well known types of sausages do not require the word "sausage" as part of the common name description. All other sausages, no matter under what name they are marketed, must have the word "sausage" added as part of the name of the product.

All dressed chicken and/or duck carcasses and cut-up chicken and/or duck portions containing kidneys, when packaged for sale, must be labelled with "may contain kidneys" and "peut contenir des reins". These declarations on breast tags, bags, packages and any other retail or bulk container constitute part of the product description and shall be shown as part of it on the main panel. The declarations shall have a minimum type height lettering of 1.6 mm.

Before using a coined name, manufacturers should verify if it is not a registered trademark in Canada. More and more meat processing plants are engaged in the

production of finger foods. Names most commonly used include: fingers, nuggets, sticks and strips. Since there are quite a few different types of products involved, what follows is an attempt at classifying those types of products.

Products which are made from a solid piece of meat may use such terms as "Nuggets, Fingers, etc." as part of the product name without further qualifications e.g. "Chicken Nuggets". Products made from chopped and formed meat may use such terms as "Nuggets, Fingers, etc." as part of the product name provided a qualifying statement describing such process is shown contiguous to the product name, e.g. "Chicken Nuggets, chopped and formed".

Products made from chopped meat and containing fillers may be described as "Nuggets, Fingers, etc." provided a descriptive name immediately follows e.g. "Nugget Shaped Chicken Burgers", otherwise, the product name must fully describe the product.

Labels containing statements referring to production methods for the live animals. An example of this type of statement is: "Hormone Free". It is not permitted to show such statements on the label of a meat product. Labels containing statements such as these will not be registered at the present time.

Net Quantity of the Meat Product

- The numerical declaration of net weight must be followed by a metric unit of measure. The symbols of units of measure which may be used are as follows: g, kg, ml or ML, l or L. No punctuation marks are permitted. Operators may ship random (catch) weight meat products without marking the actual weight on individual packages. Shipping

cartons containing catch weight products shall show a net weight declaration when shipped.

– Legislated weights

All ingredients of a meat product shall be listed in descending order of their presence. This will reflect the relative proportion of the ingredients before they are combined to form the meat product. Water and smoke are considered as ingredients and shall be listed as such. However when the mixture or preparation contains one or more of the following ingredients or components, those ingredients or components shall be shown by their common names in the list of ingredients of the meat product as if they were ingredients of that product:

- a) salt;
- b) glutamic acid or its salts;
- c) hydrolysed plant protein;
- d) aspartame;
- e) potassium chloride;
- f) peanut oil; hydrogenated or partially hydrogenated peanut oil; modified peanut oil. and;
- g) any ingredient or component that performs a function in, or has any effect on, that meat product.

Declaration of ingredients with allergenic properties or causing serious adverse reactions: More and more incidents of allergic and sensitivity reactions to both domestic and imported foods are being reported to the Canadian Food Inspection Agency (CFIA). A variety of foods contain ingredients that can cause adverse reactions in hypersensitive individuals. These reactions can vary from minor to life-threatening.

Manufacturers, importers and distributors are responsible to ensure that their products are safe and meet the labelling requirements of the legislation. Therefore, the CFIA urges them to ensure that the above foods and their derivatives are included in the list of ingredients on the labels of meat products when they are present as ingredients or components. Manufacturers should pay special attention to ingredients that are added through the use of mixtures and preparations (e.g. flavouring and seasoning preparations).

Also, it has been demonstrated that "highly refined edible oils" are virtually devoid of proteinaceous material and, hence, it is generally agreed that such highly refined oils are unlikely to cause food allergies. It is the responsibility of the manufacturer, distributor or importer to demonstrate that the highly refined oils in their products do not contain proteins. To further assist consumers in making safe food choices, the CFIA encourages manufacturers, importers and distributors to identify the plant source of ingredients, such as hydrolysed plant proteins, starches, modified starches and lecithin (e.g. hydrolysed soy protein, wheat starch, modified wheat starch, soy lecithin).

In variable formulation all meat product ingredients shall be grouped together and placed in the appropriate position in the ingredient listing and be segregated from non-meat ingredients by a semi-colon (;) or a dash (-). If meat product ingredients are fixed as to inclusion and order, segregate each meat product ingredient by a comma (,). If the meat portion varies as to inclusion or order, then it may read: "Beef, Pork and/or Mutton". If all meat product ingredients are interchangeable, then it may read: "Beef and/or Pork and/or Mutton". Designations of species should appear, in the case of variable formulation, in either of the following formats:

- (i) ingredients: may contain beef, pork, mutton and their by-products;
- (ii) ingredients: beef and/or pork and/or mutton and/or their by-products.

A filler may be listed as an ingredient, followed by a listing of all the components between parenthesis, e.g., filler (flour, skim milk powder, etc.), or the components making up the filler may be listed individually as ingredients. Additives such as antioxidants BHA (butylated hydroxyanisole), BHT (butylated hydroxytoluene) may be abbreviated, but a flavour enhancer, such as monosodium glutamate shall be spelled out in full, in the ingredient listing.

Toasted Wheat Crumb may be listed as an ingredient. Toasted Wheat Crumb is a food made by cooking a dough prepared with flour and water, which may be unleavened, or chemically or yeast leavened, and which otherwise complies with the standard described in B13.021 and B13.022 of the Food & Drug Regulations. The components of this ingredient do not have to be declared in the ingredient listing when it is added to a meat product.

The declaration of ingredients of cured meat products, such as ham and bacon, shall be shown as follows on the label:

- (i) where the list of ingredients appears on the main panel, immediately below the name of the meat product, neither naming the kind of meat product nor repeating the name is required in the ingredient listing.

Example 1:

— Smoked ham

- Cured with water, salt, sodium phosphate, sodium nitrite.

Example 2:

- Bacon
 - Artificial maple flavour added. Cured with water, salt, sugar, dextrose, sodium nitrite.
- (ii) where the ingredient listing is not immediately below the name but located elsewhere on the label, a total list of ingredients, including the kind of meat product, becomes necessary following the word "ingredients".

Example 1:

- Smoked ham
- Ingredients: ham, water, salt, sodium phosphate, sodium nitrite, smoke.

Example 2:

- Bacon
- Ingredients: Pork, water, salt, sugar, dextrose, sodium nitrite, smoke, artificial maple flavour.

The declaration of ingredients for products where mechanically separated meats have been used shall be shown as follows on the label:

- If more than one mechanically separated species meat is used in the meat block; e.g.

Mechanically Separated Chicken	26.85%
Mechanically Separated Pork	20.00%
Mechanically Separated Beef	10.00%
Mechanically Separated Veal	9.55%
Water	22.60%

Spices & Filler 11.00%

– the ingredient list should read:

- Mechanically separated meat (Chicken, Pork, Beef, Veal) water,....
- If only one mechanically separated species meat is used in the meat block; e.g.

Mechanically separated chicken 25.85%

Pork 20.00%

Beef 10.00%

Veal 9.55%

Water 22.60%

Spices & Filler 12.00%

– the ingredient list should read: Mechanically separated chicken, pork, beef, veal, water,....

– If more than one mechanically separated species meat is used in the meat block as well as boneless meats, e.g.

Mechanically separated chicken 12.85%

Mechanically separated turkey 10.00%

Mechanically separated pork 8.0%

Beef 18.00%

Pork 9.00%

Beef by-products (plasma, tripes) 8.00%

Water 22.60%

Filler & Spices 11.55%

– where the mechanically separated meats represent, in total, the highest percentage of the meat block, the ingredients list should read:

- Mechanically separated meat (chicken, turkey, pork), beef, pork, beef by-products; water,....

As per the Meat Inspection Regulations the testing of different ingredients is permitted as per the variable formulation, for a period of 12 months, using the and/or concept in the ingredient list. It is fully understood that all prepared meat products formulation, method of preparation (recipes) and labels must be registered in Ottawa by the Agri-Food Safety and Strategies Division, Process and Recipe (Labels) Unit, prior to production, as per the Meat Inspection Regulations, 1990.

To be competitive in today's marketplace, the industry must adapt rapidly to changes. In that respect, changes to the formulation of a meat product may be required on very short notice. However, label inventory and the time needed to process a new label registration may sometimes mean the loss of a business opportunity. Therefore, in those instances where one or more ingredients must be added, omitted or substituted to meet demands, the Processed and Recipe (Labels) Section could grant temporary label registration for meat products already registered. This will enable the operator to use a new formulation without changing the existing label.

To ensure uniform application of this policy, a request (by facsimile) to obtain this special permission in urgent situations must be submitted to Ottawa Headquarters, Agri-Food Safety and Strategies Division, Process and Recipe (Labels) Unit. For example, the following would be permitted:

- Mechanically separated pork to substitute pork, provided that the protein values are being met;
- Whey powder to substitute skim milk powder;

- Elimination of any ingredients from the recipe, provided that no economical fraud occurs.

Smoke and smoke flavour are ingredients and must be listed accordingly. The following designation shall be used depending on how these ingredients were added to the meat product:

- “naturally smoked” - the meat product was exposed to smoke generated from the direct combustion of hardwood, hardwood sawdust or corn cobs. This can be done either in the presence of heat or not;
- “smoke” - the meat product was treated with smoke derived directly or indirectly (i.e. liquid smoke) from hardwood, hardwood sawdust or corn cobs. In the case of liquid smoke, the term “smoke” shall be used only if the meat product was subjected to heat in the presence of a vaporised liquid smoke solution or when the meat product subjected to heat has been packaged in a casing or wrapping impregnated with liquid smoke;
- “smoke flavour” - this term shall be used when liquid smoke has been added to the meat product by methods other than those mentioned above, e.g. adding liquid smoke directly into the emulsion.

The use of edible wrappings (e.g. collagen or carrageenan) in the preparation of meat products other than sausages must be declared at the end of the ingredient list. For example, the declaration “wrapped in carrageenan”, “coated with carrageenan” or “wrapped in collagen” shall appear at the end of the ingredient list of hams wrapped in such material.

When a whole muscle cut has been injected with ground or emulsified meat particles (trimmings) in a

proportion that is up to 15% of the fresh weight (green weight) of the meat at formulation, the label of the product does not need to indicate the presence of the trimmings. The calculation is done according to the following formula:

$$\frac{\text{Ground /emulsified trimmings} + \text{meat cuts before injection}}{\text{meat cuts before injection} + \text{ground /emulsified trimmings}} \times 100 = \% \text{ added}$$

For example:

$$\frac{15 \text{ kg of trimmings} + 85 \text{ kg of cuts}}{85 \text{ kg of cuts} + 15 \text{ kg of ground / emulsified trimmings}} \times 100 = 15\% \text{ added}$$

When a whole muscle cut has been injected with ground or emulsified meat particles (trimmings) in a proportion that exceeds 15% of the fresh weight of the total meat content (green weight) at formulation, the ingredients list of the product's label needs to indicate the presence of the ground meat (pork, beef or poultry). For example, "A proportion of ground ham added" or "Ground and emulsified beef trimmings added" or "Ground and emulsified poultry trimmings added" or an equivalent statement shall appear in the list of ingredients.

Either the complete name and address of the firm that prepares the meat product, or, preceded by the words "prepared for", the name and address of the firm for whom the meat product is produced or labelled, shall appear on the label of meat products. Foreign firms shall include the name of the country in the address, while firms in Canada may indicate either the province or Canada. Multi-establishment firms may show the address of the head office instead of the address of the establishment preparing the meat product.

If the address shown is the address of a person for whom the meat product was prepared, then the name and address shall be preceded by the words "prepared for". Poultry carcasses packaged in a registered establishment for another registered establishment, may bear the name and address of the receiving establishment. Hence the receiving establishment may send its bags to the packaging establishment without any label change. The establishment number on the closure clip shall be the number of the establishment packaging the carcasses. The words "prepared for" are no longer required in this instance.

The Meat Inspection Legend

The Meat Inspection Legend is a national trade-mark. Subject to the Meat Inspection Act, it is the exclusive property of the Government of Canada and may only be used as authorised by the Meat Inspection Regulations, 1990. All labels used in connection with edible meat products produced in a registered establishment must include the Meat Inspection Legend, with the exception of labels of bulk containers of fully marked prepackaged meat products.

The Meat Inspection Legend, when placed on a label, shall have no transverse measurement through the centre of the legend of less than 12.5 mm and, where stamped or branded directly on a meat product, shall have no transverse measurement through the centre of the legend of less than 25 mm. When the Meat Inspection Legend is applied to a natural casing it shall be legible. It is not practical to stamp sausages enclosed in natural casings that have a diameter of less than 5 cm.

In the case of sausages which are enclosed in natural casings and subsequently packaged in a fully marked

container for retail sale (bearing all mandatory information), the stamping of individual casings is optional. When wieners are sold "skin-on" in artificial casings, all mandatory information must be printed on the casings. In view of the small size of the sausage, it is permitted to spread the information over three consecutive wieners. To satisfy stamping requirements, the Meat Inspection Legend shall be applied to an edible dressed carcass or portions derived thereof and to edible organs. The Meat Inspection Legend may be applied to the meat product by means of:

- stamping or branding;
- a sealed bag on which the meat inspection legend is printed or applied by means of a sticker or an insert;
- a breast tag in the case of a poultry or domesticated rabbit carcass; or
- a container bearing all the mandatory requirements.

The Meat Inspection Legend contains the registration number of the establishment producing the meat product. However, it may be applied without the registration number where the meat product is packaged in:

- (i) a hermetically sealed container that is labelled as prescribed in paragraph 60(d) of the Meat Inspection Regulations;
- (ii) a casing or bag closed by a metal clip, if the registration number is legibly engraved on the metal clip and is visible when the clip is closed, and is preceded by the abbreviation "EST"; or
- (iii) a cardboard container, a corrugated fibreboard container, a bulk container or a plastic container, if the registration number is clearly marked elsewhere

on the principal display panel, and is preceded by the abbreviation "EST".

Codes may be used on hermetically sealed containers to identify the registration number, the meat product and the date of production. The use of a code in replacement of the registration number is permitted provided the code is placed in front of the production codes (i.e. meat product, date) and is followed by either a hyphen (-), an oblique (/) or a space clearly distinguishing the establishment code from the production code. If desired, the establishment code may be placed on a separate line, above the production code. If the registration number is used, the same conditions apply.

All consumer and bulk containers used in connection with edible meat products in a registered establishment shall be labelled with storage instructions unless the meat contained therein is one of the following shelf-stable types:

- (a) commercially sterile meat products in cans, jars, or pouches (excluding pasteurised products);
- (b) dried meat products with a water activity value of 0.85 or less;
- (c) meat products which have a pH value of 4.6 or lower;
- (d) meat products packed in a 100% brine solution;
- (e) fermented meat products that have a pH level of 5.3 or less and an A_w of 0.90 or less. It is understood that the pH of 5.3 or less is achieved at the end of the fermentation period in respect of the appropriate degree/hours;
- (f) meat products for which the operator submitted to the Director, Food of Animal Origin Division, a

quality control programme and supporting data demonstrating that the process is validated to produce safe products and to ensure shelf stability.

All edible meat products, not considered as shelf stable, prepared in a registered establishment shall be labelled with storage instructions which consist of one of the following statements: "Keep refrigerated" or "Keep frozen", whichever is applicable. Storage instructions may be in the check-off form on labels of all containers (prepackaged products) or shipping containers, with the appropriate instruction checked off. The storage instructions shall be shown on the principal display panel. For certain types of institutional products, the following will also be acceptable: "Keep refrigerated if used before (date) or freeze immediately".

The words "Best Before" and "Meilleur avant" followed by the durable life date must appear on the label of a prepackaged meat product where the durable life of the meat product is 90 days or less.

All meat products shall be labelled with the production date or with a code identifying the production lot. This code or date of production must appear on the immediate container of prepackaged meat products or on a tag attached to it. For a rapid identification of the product in the case of a recall procedure, it is recommended to add this code/date of production on the shipping containers of the prepackaged meat products. This information must also appear on the bulk containers of meat products. It is possible to use the durable life date statement as an identification code of production.

The amount of water added and retained in raw-single ingredient meat products due to post-evisceration contact with water, in excess of naturally occurring

moisture, must be declared as part of the product name on the principal display panel of prepackaged products or on shipping containers for non prepackaged product. Raw single-ingredient meat products include e.g. dressed carcasses, parts of dressed carcasses, offal and giblets. Retained water may be rounded off to the nearest whole number. Retained water below 0.5% need not be declared. The permitted labelling variation is a maximum of 20 percent above the declared amount within the retained water statement.

Operators may include a no-retained-water statement on the label (optional) when no water added due to post-evisceration processing has been retained by the raw single-ingredient meat product. Amended labels to add the moisture declaration statement may be approved locally by the Veterinarian or Inspector-in-Charge in consultation with area meat hygiene programme officers. The following four phrases are permitted:

- “up to X % water retained”;
- “less than X % water retained”;
- “up to X % retained water added due to processing” ; and
- “no retained water”.

A submission to support a similar claim must be submitted by the operator to the veterinarian or inspector-in-charge for evaluation by the area meat hygiene programme labelling specialist before it is used. A claim such as “no water added” is not permitted since it is misleading under section 5 of the *Food and Drug Act*. The moisture declaration must be part of the product description, shall be conspicuous and shall be not less than half of the product’s common name or half of any

additional mandatory information (eg: "with giblets"). Packages containing a variety of raw single-ingredient meat products e.g. giblets, may be labelled by either;

- a. listing a separate declaration for each component, or
- b. a single declaration which indicates the maximum water retained by the components.

Ground meat including finely textured meat (FTM) and mechanically separated meat (MSM): Ingredients used in the preparation of red meat species ground meat, FTM, or MSM, (e.g., as applicable, bone-in cuts, trimmings, head meat, hearts, tongues) which absorb and retain any water are not permitted to be used in the preparation of red meat species ground meat, FTM or MSM. At this time, according to Canadian regulations, water cannot be added to these red meat species products.

Meat products treated with salt and water in accordance with Judaic law: Only water absorbed and retained as part of the Kosher process may be excluded from the retained water declaration provided that the product description contains the phrase "soaked and salted" or a similar phrase. The operator shall supply the veterinarian-in-charge with a letter, signed by a Rabbi serving the establishment, which clearly indicates which processing steps are part of the Kosher process.

Prepared Meat Products

Any retained water in raw single-ingredient meat products, used as ingredients, need not be declared on the labelling of prepared (including multi-ingredient) meat products, e.g. raw or cooked sausage, pre-basted turkeys, or deli meats.

However, such meat products must comply with applicable standards of identity or composition requirements for the specific prepared meat product as contained in *Meat Inspection Regulations*.

Non-mandatory Informations

Pictorial representation (vignette): A pictorial representation (vignette) may be used on containers of meat products, provided such pictorial representations are neither false nor misleading as to the character and value of the contents. Each vignette will be evaluated on its own merit.

Suggested serving: On a vignette which illustrates a food that is not part of the package and could be misleading to consumers, the words "Suggested Serving" shall be placed in proximity to the vignette. This indicates that the vignette provides a serving suggestion and does not represent the exact content of the package.

Product of Canada: Operators are encouraged to show the words "Product of Canada" on the labels of meat products prepared in registered establishments. Some importing countries make it a mandatory requirement that the wording "Product of Canada" be shown on the label used in connection with exported meat products. It is the exporter's responsibility to comply with the requirements of importing countries.

Trade marks and brand names: Trade marks and brand names may be used on labels of meat products in registered establishments. The use of the usual symbols associated with trade marks such as (r), T.M. or Reg'd T.M. are also acceptable in close proximity to a trade mark. It should be pointed out however that the mere registration of a trade mark by the Trade Marks Branch of

Industry Canada does not entitle an operator to use the registered trade mark in connection with all labels of meat products. It will be the responsibility of the operator to comply with the spirit of Article 5 of the Food and Drugs Act and Article 7 of the Consumer Packaging and Labelling Act in regard to the use of trade marks and brand names. Any label registration granted does not extend to the trade mark.

Claims regarding fat content in meat products: Claims such as "Contains not more than x% fat" or "Contains less than x% fat" are acceptable. The operator shall substantiate that his claim reflects the composition of the finished product and the label must comply with nutritional labelling. Labels with claims such as ABC packers lean or extra lean ham are not considered acceptable. Ground "meat" must be identified by one of the following claims, depending on the fat content: regular, medium, lean or extra-lean.

"This page is Intentionally Left Blank"

Bibliography

- Baas, L. W., van der Belt, M., Huisingsh, D. and Neumann, F., "Cleaner Production: What some governments are doing and what all governments can do to promote sustainability", *European Water Pollution Control*, 1992.
- Baumann, D. J., "Elimination of water pollution by packinghouse animal paunch and blood", *USEPA Water Pollution Control Research Series, Report 12060 FDS*, 1971.
- Filstrup, P., *Handbook for the Meat By-products Industry*, Alfa-Laval Slaughterhouse By-products Department, Denmark, 1976.
- Gracey, J.F. and Collins, D.S., *Meat Hygiene*, 9th Edition. Balliere Tindall. London, 1992.
- Hansen, P-I. E., "Some Environmental Aspects of Meat and By-Products Processing", *40th International Congress of Meat Science and Technology*, The Hague, Netherlands, 1994.
- Hansen, P-I. E., *Introduction of cleaner technology in Danish slaughterhouses*, Fleischwirtschaft, 1996.
- Hansen, P-I. E. and B. F. Mortensen, *Reduction of Pollution and Reclamation of Packaging House Waste Products*, in A.M. Pearson and T.R., 1992.
- Hrudey, S.E., "The management of wastewater from the meat and poultry products industry", In Barnes et.al. (eds), *Surveys in Industrial Wastewater Treatment*. Food and Allied Industries. Pitman. Great Britain, 1984.
- Johns, M., *Developments in Waste Treatment in the Meat Processing Industry—A Review of Literature, 1979–1993*. Commissioned by the Meat Research Corporation (MRC), 1993.

- Jones, H.R., *Pollution Control in Meat, Poultry and Seafood Processing*, Noyes Data Corporation. Park Ridge, New Jersey, 1974.
- McDonald, B. (ed.), *Abattoir wastewater and odour management*, CSIRO, Meat Research Laboratories. Australia, 1990.
- McNeil, I. and Husband, P., "Water and Waste Minimisation", *Optimisation of Water Use and Control of Waste in Abattoirs*. Australian Meat Technology Pty Ltd., 1995.
- Ockerman, H.W. and Hansen, C.L., *Animal By-Product Processing and Utilization*, Technomic Publishing Co., Inc. Lancaster, USA, 2000.
- Pearson, A.M. and Dutson, T.R. (eds), "Inedible Meat By-Products", *Advances in Meat Research, Volume 8*. Elsevier Applied Science. Barking, UK, 1992.
- Savell, J.W. and Smith, G.C., *Laboratory Manual for Meat Science*. 6th Edition. American Press. Boston, Massachusetts.1998.
- Tenorio, D.O., Esquerra, R.L. et. al., *Pollution Prevention and Control Guide for Slaughterhouse Industry*. Environmental Division, Industrial Development Institute, Department of Science and Technology and Animal Products Development Center, Bureau of Animal Industry, Department of Agriculture, The Philippines,1996.

Index

- Aerobic bacteria 66
Ante-mortem Inspection 90
Authorised Meat Inspectors (AMIs) 86
- Bone-in method 142
Broiling 161
- Campylobacter 9
Canadian Food Inspection Agency (CFIA) 250
Chief Environmental Health Officers (CEHOs) 90
Clostridium botulinum 69
Coarse comminution 214
Connective Tissue 186
- Dark, Firm and Dry (DFD) 139, 188
Defrosting 7
Digital thermometers 15
Dry-curing 205
Dry-heat methods 136
- Emulsion-type sausages 214
Environmental Health Officers (EHOs) 86
- Facultative anaerobes 67
Fatty Tissues 186
Finely Textured Meat (FTM) 263
Flavour enhancement 191
- Food and Drugs Act and Regulations 233
Food Thermometer 12
Foodborne illness 13
Food-poisoning bacteria 67
Fresh Meat Export 86
- Heat Treatment 197
High standards of hygiene 159
Hydrolysed plant proteins 251
- Ice Water Method 17
Individual drumsticks 9
- Justice of the Peace (JP) 88
- Lamb carcasses 156
Lamb Cutting 155
- Meat and Livestock Commission (MLC) 93
Meat Hygiene Service (MHS) 85
Meat Storing 2
Mechanically-operated instrument 78
Metallic equipment 213
Microbial growth 65
Microwave safe cookware 17
Microwave-safe meat thermometer 18
Muscle Tissue 185
Muscle-boning method 147

- Negative resolution procedure 77
- Non-prepackaged meat products 237
- Nutritional value 136
- Official Veterinary Surgeon (OVS) 89
- On-the-rail Boning 151
- Overcomminution 215
- Over-wrapped supermarket trays 6
- Pale, Soft and Exudative (PSE) 139
- Pan-broiling 161
- Partial Cooking 11
- Pathogenic bacteria 13
- Perishable foods 3
- Personal hygiene 81
- Pharmaceutical products 99
- Poisonous chemicals 64
- Porcine Stress Syndrome (PSS) 139
- Post-evisceration contact 261
- Postmortem inspection 84
- Postmortem Inspection 92
- Preservative effect 193
- Record-keeping requirements 80
- Refreezing 7
- Relative Humidity (RH) 67
- Representative organisations 77
- Royal College of Veterinary Surgeons (RCVS) 96
- Semi-transparent containers 238
- Slaughterhouse licences 79
- Staphylococcus aureus 68
- Sterilisation 102
- Storage containers 3
- Total Viable Count of Bacteria (TVC) 64
- Unhygienic handling 219
- Vexar Netting 236
- Vironmental Health Officers (EHOs) 86