Guidelines for the safe manufacture of refrigerated wheat-flour noodles

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Food Science Australia

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Guidelines for the safe manufacture of refrigerated wheat-flour noodles

Brigitte Cox, Yang Huang and Nancy Jensen

Food Science Australia

Date: 7/5/2003
Preface

Studies have shown that the risk of foodborne illness from refrigerated wheat-flour noodles is generally low in Australia, provided that sufficient ‘hurdles’ are in place to control the growth of microbes in the product. This Guide has been produced to assist small Australian manufacturers to produce safe products.

There are various types of refrigerated wheat-flour noodles, each with food safety hazards. These can be controlled to acceptable levels by following good manufacturing practices, taking care to ensure that all equipment is clean and that certain critical points in the process are monitored and controlled within acceptable limits.

The Guide covers the major types of refrigerated wheat-flour noodles and the significant food safety hazards associated with them. Accepted methods for controlling the identified hazards are described.

The Guide has been compiled by scientists from Value Added Wheat CRC and Food Science Australia. The excellent contribution of Tiffany Beer (Integrated Food Solutions) is also gratefully acknowledged.
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PATHOGENIC BACTERIA IMPORTANT IN THE MANUFACTURE OF REFRIGERATED WHEAT-FLOUR NOODLES

Staphylococcus aureus (S. aureus)
Bacillus cereus (B. cereus)

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WHAT ARE MICROBES?

Algae
Protozoa
Bacteria
Moulds
Yeast
Viruses

SOURCES OF MICROBIAL CONTAMINATION OF FOODS

FACTORS AFFECTING THE GROWTH OF MICROBES

Nutrients
Temperature
Water activity ($a_w$)
Time
pH of the food
Gas atmosphere

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GLOSSARY
What these guidelines contain

These guidelines on the safe manufacture of refrigerated wheat-flour noodles have been written in three parts:

Part 1: Information about refrigerated wheat-flour noodles

This section includes the history and basic categories of refrigerated wheat-flour noodles. It also provides details about food poisoning outbreaks and recalls involving refrigerated wheat-flour noodles.

Part 2: How to set up your Food Safety Program

To put a Food Safety Program in place you need to look closely at your manufacturing operation. Food Safety Programs are based on Hazard Analysis Critical Control Points (HACCP) and this section shows you how to implement a HACCP plan. This is done in two stages.

1. Support programs

For a HACCP plan to be effective, support programs must first be put in place. Support programs cover such operations as Good Manufacturing Practices (GMP), recall procedures, staff training and a Supplier Management Program. Areas that need to be considered in the development of each of these support programs are covered in this section.

2. HACCP plan

We then move onto the development of the HACCP plan itself. There are twelve steps and each step is explained and illustrated with example forms.

Part 3: Pathogenic bacteria important in the manufacture of refrigerated wheat-flour noodles

Although microbiological hazards are only a part of the hazards you face, they are the major cause of foodborne illness. This section discusses the particular pathogens you must control during the manufacture of refrigerated wheat-flour noodles.

Appendix 1 gives you background information on the type of microbes (germs) that are found in food and the factors affecting their growth.

Appendix 2 outlines hazards that you may encounter in the manufacture of refrigerated noodles and provides examples of control measures.

Finally, new terms are described in a glossary at the end of this book.

As a noodle manufacturer - what is in this for me?

The implementation of these guidelines will benefit your business in several ways:

- Reduce the risk of your product causing a food poisoning outbreak.
- Improve your control over your business through documentation.
- Provide a documented history of production and product records that may be of help in a spoilage situation, and a record of why certain changes were made (i.e. corporate history information is often lost if/when staff move elsewhere).
- Provide a defensible position against civil litigation and criminal action in the event of a foodborne outbreak resulting from one of your products.
- Provide better industry-wide image and consumer confidence.
Important references


Further reading


Part 1:
Information on refrigerated wheat-flour noodles
Introduction

Refrigerated wheat-flour noodles cover a wide spectrum of products depending on the size of the noodle strand, the type of raw materials used in their manufacture, the method of processing, and the form of the product on the market. The two main types are white-salted noodles and yellow-alkaline noodles, with or without egg. Products may be packaged in air, under vacuum or in a mixture of gases (usually carbon dioxide and nitrogen). The shelf life of refrigerated wheat-flour noodles is generally 3 to 7 days although under some conditions 3 to 4 weeks may be given. Storage should be at less than or equal to 5°C. Products may not be completely cooked when packaged, as it is intended the products will be cooked before consumption.

History of refrigerated wheat-flour noodles

Processes for manufacturing refrigerated wheat-flour noodles were brought to Australia by families who emigrated from Asia. The factories producing refrigerated noodles generally tend to be small-scale and often have only limited technical support. Most refrigerated wheat-flour noodles in Australia are sold through supermarkets and Asian grocery stores.

Basic categories of refrigerated wheat-flour noodles

There are two main types, yellow-alkaline noodles and white-salted noodles.

Yellow-alkaline noodles

Yellow-alkaline noodles (pH 9) are generally made from flour (100 parts), water (32-35 parts) and a solution of alkaline salts known as kansui or lye water (1 part), with or without egg. These salts are usually a mixture of sodium and potassium carbonates, or sodium hydroxide in some cases. The alkaline salts confer a unique flavour and texture to the noodles and contribute to the typical natural yellow colour, which is enhanced at high pH. Flours from hard wheat with a protein content of 10-12% and a mellow gluten quality are recommended for the manufacture of fresh alkaline noodles. The desired characteristics of these noodles are: a bright, even light yellow appearance, free of any darkening or discoloration, a chewy and elastic texture with some degree of springiness, firm to the bite when cooked.

There are three basic types of yellow-alkaline noodles:

- Raw yellow-alkaline noodles
- Boiled yellow-alkaline noodles (Hokkien)
- Steamed yellow-alkaline noodles

Hokkien and steamed noodles are essentially raw yellow-alkaline noodles that have been partially cooked until there is only a fine core of raw dough in the centre, surrounded by cooked or gelatinised dough. They are given a final cook prior to consumption, during which time the cooked zone extends to the centre.

All noodles, including those that are raw and partially cooked need to be protected from airborne contaminants prior to packaging because their surface provides an ideal substrate for bacterial, yeast and mould growth.

White-salted noodles

White-salted noodles are made of flour, water and common salt, with or without egg. White-salted noodles have a pH around 7. There are two main types:
- Raw white-salted noodles
- Boiled white-salted noodles (Udon)

Udon noodles were developed in Japan. They are cooked in boiling water until the zone of gelatinisation extends throughout the noodles.

Food poisoning outbreaks and recalls involving refrigerated noodles

In Australia and around the world, refrigerated noodles have caused outbreaks of foodborne illness.

For example, in a catered school festival in Victoria in 1999, a noodle dish containing ham and eggs was served, and 38 people became sick. Although no pathogen was found in the products, poor food handling and storage were causes that contributed to the outbreak (Anonymous, 1999). In 1992, there was a *Staphylococcus* gastroenteritis outbreak in Canberra attributed to noodles (Cheah et al. 1992).

In addition, in 1997 there was a recall of refrigerated stir-fry noodles in Australia, which was due to high bacterial levels (see Table 1 and ANZFA 2001b).

Table 1  Levels of bacteria in refrigerated stir-fry noodles recalled in 1997

<table>
<thead>
<tr>
<th>Bacteria</th>
<th>Levels (cfu*/g noodles)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Staphylococcus</em></td>
<td>&gt;15,000</td>
</tr>
<tr>
<td>Coliforms</td>
<td>&gt;1100</td>
</tr>
<tr>
<td>Standard plate count</td>
<td>&gt;40,000,000</td>
</tr>
</tbody>
</table>

*cfu/g: colony forming units per gram*
Part 2:

The basics: setting up your Food Safety Program
Your responsibility for food safety

Current Food Safety Standards require that food businesses need to have more control over their food operations and they need to be able to demonstrate that they are producing safe food. To protect the public and produce safe food you need to:

- comply with the law,
- only obtain food from safe sources,
- train staff so they know what they need to do,
- make sure the workplace is hygienic, cleaned, sanitised and kept in good repair,
- provide the necessary equipment in good working order,
- understand the hazards associated with food and take all necessary steps to control them,
- take ownership in developing a Food Safety Program and keeping it up to date,
- calibrate any equipment you use to control your hazards.

Provisions that apply to refrigerated wheat-flour noodles in the Food Standards Code include:

- Chapter 1, General Food Standards, Standard 1.2 Labelling and other information requirements
- Chapter 2, Food Product Standards, Standard 2.1.1 Cereal and cereal products
- Chapter 2, Food Product Standards, Standard 2.2.2 Egg and egg products
- Chapter 3, Food Safety Standards (Australia only), Standard 3.1.1 Interpretation and application
- Chapter 3, Food Safety Standards (Australia only), Standard 3.2.1 Food safety programs
- Chapter 3, Food Safety Standards (Australia only), Standard 3.2.2 Food safety practices and general requirements
- Chapter 3, Food Safety Standards (Australia only), Standard 3.2.3 Food premises and equipment

What is a Food Safety Program?

FSANZ describes a Food Safety Program as a program set out in a written document retained at the premises of the food business, including records of compliance and other related actions, that:

- systematically identifies the potential hazards that may be reasonably expected to occur in all food handling operations of the food business,
- identifies the process step(s) in a food handling operation, at which each hazard identified can be controlled and how it is to be controlled,
- provides for the systematic monitoring of those controls,
- provides appropriate corrective actions to be used when those control points are found not to be under control,
- provides for the regular review of the program by the food business to ensure its adequacy,
- provides for appropriate records to be made and kept by the food business demonstrating action taken in relation to, or in compliance with, the Food Safety Program.

There is no set structure for a Food Safety Program. It is based on a system known as Hazard Analysis Critical Control Points (HACCP) that relies on a foundation of support programs (Figure 1).
Figure 1  What a Food Safety Program looks like

The following sections describe the support programs and how to set up your HACCP plan step by step.
1. Setting up support programs

Supplier management programs (raw material purchase)

There are various means of managing materials purchased from suppliers. The aim is to ensure that your suppliers have produced your raw materials in a controlled manner so that they do not compromise the Food Safety Program of your business.

Records of all suppliers’ products and all suppliers used must be kept. It is also wise if possible to be aware of a number of suppliers for each item. This provides financial as well as safety benefits and enables you to ensure supply from safe sources in the event of problems, shut downs or recalls with one supplier.

The steps in implementing a supplier management program are:

- List all raw materials.
- List all suppliers (including alternate suppliers), details of addresses, contact people (quality or safety specialists if the suppliers have them).
- Categorise supplier products according to risk, e.g. high risk products include ‘potentially hazardous’ foods (those that will support microbial growth) that you buy from suppliers and that will not undergo a hazard control process at your premises, or those foods that might be contaminated with chemicals or foreign objects, e.g. glass fragments that will not be removed by processing at your facility. In the case of refrigerated wheat-flour noodles, egg (if used) is the high risk ingredient from a bacteriological point of view, but flour and the alkaline salts could become a safety issue if they contain foreign objects or, in the case of the salts, if they are not food-grade.
- Send all suppliers a self-audit questionnaire. This might ask them for information such as do they have a system for screening out foreign materials before packaging? Or whether they produce non-food-grade chemicals and if so what system they have in place to stop non-food grade chemicals being accidentally supplied for use in food? It is best to send out a form you have designed and which the supplier can fill in easily by, say, ticking a box.
- Review the self-audit information from your suppliers and develop an ongoing strategy for management. This might mean deleting some suppliers and finding new ones, requesting suppliers themselves to implement Food Safety Programs based upon HACCP if they don’t have one, requiring certification documents from suppliers with each delivery of goods, or inspection of initial suppliers’ premises to confirm that they have control of the relevant hazards.
- Develop product safety specifications for relevant bought-in products e.g. delivery temperature for eggs, microbiological specifications, or certification requirements. These specifications might include quality and safety specifications, but remember, once you have formulated the safety specifications these are non-negotiable unless your supplier can demonstrate the product is still safe. For example, your specification might be for frozen egg pulp and the supplier sends fresh egg pulp. If the product is pasteurised you can still accept it, but if it is not, you should send it back. It is a good idea to talk to suppliers directly and agree on the practices that the supplier will have to put into place and discuss achievable specifications for your products.
- Audit your supplier about once a year – check test results, records and if appropriate, conduct an on-site inspection.

Good Manufacturing Practices (GMP)

Good Manufacturing Practice (GMP) ensures that food is produced in such a manner that it is fit for human consumption. GMP covers a wide range of activities from building design and the condition of the surroundings, to equipment maintenance, waste disposal and staff hygiene issues.
Design and construction of premises and equipment

Standard 3.2.3 Food premises and equipment, in the Australian Food Standards Code, states the requirements for the design and construction of your premises.

To meet this standard, you need to ensure that the layout of the premises minimises opportunities for food contamination. You are required to ensure that your food premises, fixtures, fittings, equipment and transport vehicles are designed and constructed to be easily cleaned and, where necessary, sanitised. All food contact surfaces must also be made of non-toxic materials. You must also ensure that any food preparation premises are provided with the necessary services of potable water and suitable waste disposal facilities. In this section we will concentrate on the reasons behind the standards — why you need to incorporate specific elements into designing and constructing your plant. You should read all the relevant standards and codes of practice, which you can obtain from the web or from your local Government Bookshop.

Elements that must be addressed in well-constructed and designed premises are:

- Having a safe water supply.
- Maintaining food contact surfaces in good, clean condition.
- Preventing cross-contamination from unsanitary objects.
- Maintaining hand washing, hand sanitising and toilet facilities.
- Protecting food, food packaging materials, and food contact surfaces from contamination with lubricants, fuel, pesticides, cleaning compounds, sanitising agents, condensate, and other chemical, physical, and biological contaminants.
- Labelling, storing and using toxic compounds in a safe manner.
- Ensuring that cooked product is not likely to be contaminated by raw ingredients, by equipment used for raw dough, or by people who handle raw noodles. Product flow should be designed so that cooked product does not move through raw material or raw dough handling areas.
- Ensuring that you have sufficient refrigeration capacity for your needs.
- Confining and removing wastes.
- Constructing equipment from food-safe materials.
- Purchasing only equipment that is easy to keep clean.

All of the above are concerned with preventing contamination of materials and final products either with microbes, foreign objects, equipment and the workplace environment, or with chemicals used in food plants.

Separation of raw from cooked products

If you process raw and cooked noodles in the same premises it is possible that your product will become contaminated from ‘traffic’ including people, raw food and moveable equipment.

- Ideally, product should 'flow' from one end of the plant to the opposite end.
- In reality, this is not always possible. At least you should assign areas to cooked and non-cooked products.
- Try to avoid cooked noodles backtracking through areas assigned to uncooked dough and raw materials.
- Cooked foods need to be covered wherever practicable.
- People traffic from the uncooked products area to the cooked products area should be avoided. Staff should be encouraged to stay in their area.
Use of dedicated equipment for cooked products

- Equipment, including conveyors and packing machines used for cooked products must be located in the cooked products area and used only for cooked products.

- Where only a single cool room is available for cooked and uncooked noodles, they should be kept apart e.g. on different sides of the cool room. Unpackaged noodles should be covered during storage in the cool room.

Equipment calibration

Look around your plant and you’ll see equipment that measures key parameters, such as temperature and weight. Regular calibration is especially important for equipment used to monitor Critical Control Points (CCPs, p27), otherwise the process may be out of control - and you won’t even know until something goes wrong. You may be able to do this yourself, or you may need to get someone in to do it for you. Look at any instruction books that came with the equipment – they may have guidelines on how to calibrate.

To ensure regular calibration your first step is to identify every piece of equipment which needs calibrating, such as:

- thermometers,
- temperature gauges on cool rooms,
- temperature gauges on cookers,
- temperature gauges on steamers,
- pH meter,
- water activity meter,
- scales,
- metal detectors.

Next, make a schedule for calibrating all measuring equipment on your list (see Table 2).

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Date to calibrate</th>
<th>Date calibrated</th>
<th>Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermometer 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH meter</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Approved: Date:

Thermometers

Calibrate your working thermometers (e.g. hand held) on a regular basis at a temperature close to the temperature range where the thermometer is routinely used (refrigeration temperature or cooking temperature).

Cooker and cool room probes can’t be readily removed, so calibrate them in-place using a calibrated working temperature probe.
Regular calibration may involve comparing the temperature probe against a mercury in glass thermometer at 0°C (stirred ice water mixture) or 100°C (steam from a kettle). Do not take the mercury in glass thermometer into the production area where it can introduce further hazards. All temperature probes should be professionally calibrated about once a year.

Many medium- and large-sized premises have a reference thermometer calibrated by a National Association of Testing Authorities (NATA) accredited laboratory. This should only be used for calibrating working thermometers, and should itself be calibrated annually by a service company that is accredited by NATA to perform such calibrations.

**Scales**

Scales should be calibrated by using certified weights. You'll need to get the weights checked annually by a NATA accredited laboratory.

**General equipment**

You'll probably have a number of instruments like pH meters, and metal detectors that can be calibrated according to the manufacturer requirements. You must do this regularly, as often as instructed by the manufacturer.

**Standard Sanitation Operating Procedures (SSOPs)**

You'll need a documented cleaning and sanitising program that shows when and how all parts of the factory are cleaned. Effective procedures are described in Standards Australia AS 4709-2001 - Guide to cleaning and sanitising of plant and equipment in the food industry, and ANZFA (2001a) Safe Food Australia, Appendix 4: Cleaning and sanitising surfaces and utensils, which you can download at [http://www.anzfa.gov.au/mediareleasespublications/publications/safefoodaustralia2nd519.cfm](http://www.anzfa.gov.au/mediareleasespublications/publications/safefoodaustralia2nd519.cfm).

**The difference between cleaning and sanitisation**

There are two parts to your program: cleaning and sanitising.

**Cleaning** is the removal of soils (waste, dirt, grease, food scraps, etc.) from equipment and premises and usually requires the use of detergents. Detergents are designed to remove specific types of soils. You will also require clean potable water to rinse away the detergent and trapped soil.

A successful cleaning process results in equipment and surfaces that are visibly free of any soils or deposits and are clean to the touch. Soil must be completely removed before chemicals are used for sanitisation because it can protect pathogens from the action of sanitisers and can also inactivate sanitisers.

**Sanitisng** step destroys microbes that remain in or on the equipment after cleaning. Sanitation may be carried out by using hot water, steam or a chemical sanitiser. If using chemicals, it is essential that the surface should be clean prior to sanitising as noted above.

**Setting up your cleaning and sanitising program**

In large plants you will need to appoint a specific person to be responsible for making sure that all aspects of hygiene throughout the plant are taken care of. In a small operation it is possible for everyone to share responsibility for ensuring that hygiene standards are maintained.

If you use contract cleaners, they need to be made aware of your cleaning requirements and provide documentation that they have carried out the required cleaning and have cleaned to the agreed standard. You should also monitor the cleanliness of your plant through visual or, if necessary, swab tests to confirm the program is effective.

A cleaning and sanitising program should include:

- areas to be cleaned,
- how often cleaning should be performed,
- who is responsible for cleaning each item or area,
- steps to be followed during cleaning,
- how to dismantle and reassemble equipment,
- concentrations of chemicals used,
- contact time for chemicals or other sanitation method,
- water temperature,
- drainage and drying procedures,
- any other details required for particular situations.

Table 3 and Table 4 show you examples of a cleaning schedule and a cleaning sheet, respectively. The specific detergent and sanitiser concentrations and other details can be obtained from the label of the chemicals used.

Table 3  Example of a cleaning schedule

<table>
<thead>
<tr>
<th>Equipment</th>
<th>When</th>
<th>Who</th>
<th>How</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooked product chiller</td>
<td>Weekly</td>
<td>Contract cleaner</td>
<td>Cleaning method 5</td>
</tr>
<tr>
<td>Mixer</td>
<td>Daily</td>
<td>Mixer operative</td>
<td>Cleaning method 1</td>
</tr>
<tr>
<td>Cooker</td>
<td>Between batches</td>
<td>Cook</td>
<td>Cleaning method 2</td>
</tr>
</tbody>
</table>

Approved: __________________________  Date: __________________________

Table 4  Example of a cleaning sheet

<table>
<thead>
<tr>
<th>Date: 5th July 2002</th>
<th>Authorisation: The Boss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item: Dough mixer</td>
<td></td>
</tr>
<tr>
<td>Detergent: Squeaky cleaner</td>
<td>Sanitiser: Squeaky killer</td>
</tr>
<tr>
<td>Detergent concentration: 100 mL per 10 Litres</td>
<td>Sanitiser concentration: 80 mL per 10 Litres</td>
</tr>
<tr>
<td>Water temperature: 60°C</td>
<td>Water temperature: 40°C</td>
</tr>
<tr>
<td>Contact time: 2 minutes</td>
<td>Contact time: 5 minutes</td>
</tr>
</tbody>
</table>

Instructions:

1. Disconnect power supply.
2. Dry brush waste from the blades of the mixer, top and outer parts.
3. Remove bowl and brush out the inside.
4. etc.

Approved: __________________________  Date: __________________________
You need to consider the cleaning and sanitising of:

- processing and storage areas including all walls, floors, ceilings and doors,
- processing and packaging equipment,
- chillers and other refrigeration equipment,
- toilets, amenities, canteens and offices.

General work areas and equipment should be cleaned and sanitised at the start and end of each shift. Equipment and utensils should be cleaned and sanitised periodically during the day.

- Equipment should be designed so that liquids, including washing or sanitising solutions, can drain freely so that it dries out between uses. It should also be designed so that the amount of product building up on the surfaces during the day is minimal and is easy to remove.
- High volume/low pressure cleaning systems are preferable to high pressure systems because they minimise splashing and aerosol production.
- The use of porous and absorbent items (e.g. rags, wooden handled tools) is not acceptable in food processing areas because they are difficult to clean and may harbour bacteria.
- Separate cleaning brushes should be used for food contact and non-food contact surfaces – it helps if they're colour coded. Brushes should be sanitised and stored correctly between uses. Once they show signs of wear they should be replaced.
- Hoses, when not in use, should be stored on reels or racks.
- Conveyors and shielding should be cleaned regularly.
- Drains, covers and sieves should be cleaned and sanitised after each production run.
- Shelving and handles inside chillers require cleaning about twice a week while outside door handles and rails need cleaning daily.
- Door seals should be maintained in good condition and kept as dry as possible. They should be cleaned regularly.
- Sheeting machines may be dry brushed and kept dry, rather than washed. However, occasional swab samples should be taken to verify that there is no build-up of microbes. After scheduled maintenance, all parts should be cleaned with detergent and sanitised.

How to clean and sanitise effectively

A basic cleaning and sanitising system includes the following elements:

- dry clean the area, i.e. remove scraps and other food residues,
- rinse with warm water,
- apply a detergent solution or foam and leave on all surfaces for the time specified by the manufacturer,
- scrub surfaces to loosen and remove dirt,
- rinse with potable water and drain,
- apply a chemical sanitiser and leave on all surfaces for the time specified by the manufacturer, or sanitise with hot water or steam,
- rinse with potable water and drain (for chemical sanitisers which are not sold as ‘no-rinse’),
- allow surfaces and equipment to dry.
Cleaning compounds should be approved for use in food processing premises. They should not come into contact with ingredients, packaging materials or final product during cleaning and sanitising of rooms, equipment or utensils.

Selection of detergent should be based on the following factors:

- type of surface (e.g. metal, plastic, tile, concrete, perspex),
- type of contamination (e.g. flour, starch, egg, cooked-on product),
- application method (see below),
- water quality (e.g. hardness),
- water temperature,
- time available for cleaning.

Cleaning methods include manual (scrub by hand), pressure, foam or gel, soaking and in-place cleaning using only detergents approved for the food industry. Your detergent supplier will advise you on the most suitable detergent and application methods.

Sanitising (reducing bacteria to acceptable levels) can be done using:

- steam for at least 1 min contact time,
- hot water for at least 2 min at 77°C - usually for utensils,
- chemicals - application of approved sanitisers (e.g. halogens, quaternary ammonium compounds) at the concentration and for the time recommended by the manufacturer. Food contact surfaces should be adequately rinsed after the use of chemical sanitisers and prior to any food contact unless these chemicals are specifically approved as no-rinse.

Sanitation can take place immediately after cleaning, leaving the sanitiser on until just before the equipment is to be used. When you allow equipment or surfaces to stand unused for a period of time, make sure they are dry to prevent the growth of any bacteria on the surface or that they are completely covered by the correct concentration of sanitiser. Puddles of water can harbour bacteria that can then grow to high numbers.

You should validate the cleaning and sanitation by visual inspection and occasional microbial testing of surface (Note: Commercial microbial testing kits are available). It is important to review your cleaning and sanitising program regularly, taking into account your records of visual inspection, microbiological tests of product contact surfaces, and any formulation changes.

**Good Hygienic Practices (GHP)**

You should set out the necessary hygiene conditions for producing food that is safe and suitable for consumption. Although hygiene practices may differ considerably for the various food commodities, there are general hygiene principles that apply throughout the food chain to the point of sale.

- People known or suspected to be suffering from, or to be a carrier of a disease or illness likely to be transmitted through food e.g. hepatitis A, gastroenteritis, must not be allowed to enter any food handling area if there is a likelihood of their contamination of food. This is a regulatory requirement of Standard 3.2.2.
- You should encourage staff with the following symptoms: jaundice, diarrhoea, vomiting, fever, sore throat with fever, visibly infected skin lesions, discharges from the ear, eye or nose, to stay home from work. They should be sent to a doctor if necessary.
- Food handlers must have a high level of personal cleanliness. You should provide them with suitable protective clothing, head covering and footwear.
• Ideally noodles should not be handled with bare hands. Gloves can be worn, but they must be changed regularly. Whether gloves are worn or not, it is essential that hands are frequently washed and sanitised. Staff should be trained how to wash their hands correctly.

• Personnel should always wash their hands with soap at the start of food handling activities and immediately after using the toilet. Hand washing should also occur after blowing the nose, eating, smoking and duties where hands touch surfaces that may be contaminated by microbes. You should ensure that hot water, soap and towels are provided.

• Cuts and wounds, where personnel are permitted to continue working, should be covered by suitable waterproof dressings. Special blue coloured dressings are available so that they are easily detected in the event that they fall into food. Such staff must not directly handle noodles or noodle dough.

• People engaged in food handling activities should not smoke, spit, chew or eat, sneeze or cough over unprotected food.

• Personal effects, e.g. jewellery, watches, pins or other items, should not be worn or brought into food handling areas. You need to enforce this policy and train your staff.

• Visitors to food manufacturing, processing or handling areas should wear protective clothing and not walk through process areas unless there is a specific need to do so.

Food safety practices and general requirements

Receipt and storage of raw materials

In refrigerated noodle manufacture you use flour, salt, egg, colouring agents and other ingredients.

When you receive raw materials and ingredients, inspect them for wholesomeness and that they comply with your specifications. Record their condition on the invoice or receipt form, including:

• any necessary temperature checks on receipt, e.g. on egg pulp,

• inspection for foreign objects which could, if they found their way into the product, be hazardous,

• package integrity (including packaging materials and the packaging of purchased food items).

Corrective action should apply to any products received that are out of specification. This will need to be specified along with the staff who are responsible for the maintenance of produce records and training of staff. The records should be kept for future use.

Once you've accepted them, raw materials should be:

• moved to storage or directed to processing as soon as possible,

• maintained at appropriate temperatures and humidity for safety,

• protected against contamination or damage to the package and contents by pests and sharp objects,

• stored in their own or in clean containers on racks or shelves to ensure no contact with the floor,

• used on a first in, first out (FIFO) basis.

Any goods to be returned to the supplier should be clearly identified and stored in a designated area.

Receipt and storage of packaging materials

Packaging materials and packaging practices used for refrigerated noodles should comply with Australian Standard AS 2070-1999, Plastics materials for food contact use. Packaging, especially partially used rolls and cartons, needs to be stored in a dust and vermin proof room on racks at least 30 cm above the floor to prevent contamination. Packaging should be used on a FIFO basis.
Chemicals
The refrigerated noodle industry often uses lye water as a noodle ingredient and may also use food dyes. You should only use food-grade chemicals, and ensure they are made up as directed. Your suppliers should provide you with the Material Safety Data Sheet (MSDS) for each chemical. Different chemicals may look very similar - ensure that they are clearly labelled.

Cleaning chemicals should be clearly labelled and kept in a separate area to ensure that they are not accidentally added to food. MSDS should be obtained for cleaning and sanitising agents.

Tempering and thawing of pasteurised liquid egg
Frozen food is not sterile and can contain pathogens that can grow if food is thawed incorrectly. To control the growth of pathogens, thawing needs to be carried out under controlled conditions, e.g. in a chiller. This will require some planning. Follow the manufacturer's instruction to ensure the egg is ready to use when required.

Thawing is normally carried out by placing the frozen pasteurised egg in a chiller (less than or equal to 5°C) for approximately 48 h. Thawed egg should be stored between 0°C and 5°C and used within 72 h of thawing.

Weighing
All ingredients including preservatives, dyes and lye water should be weighed out accurately.

Mixing, sheeting and cutting
Heat will be generated during mixing, rolling and cutting. Because some dough fragments may be retained in the equipment, the numbers of microbes may increase on the equipment during the day. For this reason, at day's end, all material in the mixer, roller and cutter should be discarded as it can 'seed' tomorrow's batch with possibly dangerous bacteria. Equipment should be also cleaned and sanitised at the end of each day's production, and if possible between batches.

Cooking
- The cooking process makes the noodles palatable, but also kills most of the microbes present in the dough, although spores and toxins may not be destroyed.
- To kill microbes effectively during cooking, you must follow the proper time and temperature specifications you have set. This must be recorded for every batch of noodles.
- The timing of the cook should start from when the temperature of the water containing the noodle batch reaches the required temperature, not from when the noodles are added to the water.
- Temperatures should be checked with calibrated thermometers and used as described in the instruction manual.
- Because of the way noodle dough is prepared, it is possible that pathogens may be located inside the noodle strands. It is therefore important that the noodle centre reaches 76°C, which will kill microbial cells. This is called a critical limit. It is likely that your cooking temperature (then called an 'operating limit', see p 29) will exceed this critical limit. Critical limits are required for safety and must be recorded in your HACCP plan (see p 18 and onwards).
- The effectiveness of the cooking process must be validated to check that the cooking process provides an effective kill step. This need only be done occasionally by measuring that the noodles actually reach 76°C when cooked for the time specified.

Cooling
- This is likely to be a Critical Control Point (CCP, see p 27) as the final cook by the consumer or end user cannot be relied on to make the noodles safe.
- Most bacterial spores tolerate much higher temperatures than bacterial cells and will survive cooking. Some sporeformers, such as Bacillus cereus also produce heat-stable toxins that are not destroyed when the consumer recooks the product. Cooling of processed noodles must therefore be
used to prevent the germination of spores and subsequent toxin formation prior to packaging. To do this, the cooling must be relatively quick and efficient.

- Cooling of cooked wheat-flour noodles may be by:
  - water showers in the oven or outside the oven,
  - running water or chlorinated water baths,
  - refrigerated airflow.

- Standard 3.2.2 gives the required cooling schedule for foods. You need to ensure that your product is able to reach less than or equal to 5°C within a maximum of 6 hours. You may need to change your practices to achieve this, or purchase a dedicated chilling system (i.e. removing heat) for chilling rather than storing (i.e. maintaining low temperatures).

- The water used for cooling must be clean and free from pathogens. Town water is usually suitable, although some manufacturers may also wish to chlorinate their water to 100 mg/L free chlorine as an extra precaution. If a water bath is used there should be a constant overflow so that bacteria do not build up to levels which contaminate the cooked noodles.

**Packaging**

- Packaging protects the noodles from further contamination, provided the seals are correctly formed and pinholes and tears are not present.

- The packaging material used should be strong enough to avoid damage during distribution, provide strong heat seals, have good moisture barrier properties, and if a modified atmosphere is used in the pack, have good gas barrier properties.

- There should be a designated area for packaging to avoid cross-contamination to the cooked products from raw material and people ‘traffic’.

- If packaging manually, avoid direct contact of hands with the cooked noodles. If this is unavoidable, hands should be thoroughly washed before the contact (see Good Hygienic Practices for details).

**Labelling**

Regulations covering labelling and coding can be found in the Chapter 1 of the Food Standards Code. Standard 1.2 Labelling and other information requirements.

The information you give on packages should include:

- **name** of the food, *e.g.* Shanghai noodles.
- **lot identification**, *e.g.* a date or a batch number.
- **name and address of supplier**.
- **mandatory statement**, *e.g.* a statement to the effect that the product is unpasteurised when unpasteurised eggs are used,
- **statement of ingredients** including every ingredient in the food, especially the presence of wheat flour,
- **date marking**, *e.g.* best before date.
- **directions for use and storage**, *e.g.* boil or stir fry for 5 min, store at less than or equal to 5°C.

**Chilled storage of wheat-flour noodles**

Correct storage conditions require that temperatures of less than or equal to 5°C are maintained and recorded to ensure the safety of refrigerated wheat-flour noodles.

- Refrigerated noodles should be placed off the floor in dedicated chillers.
- No raw materials, ingredients or additives should be stored in the same chiller as unpackaged, cooked noodles.
- Chillers should have a temperature probe installed in the warmest area. The probe should be connected to an easy to read temperature gauge or a continuous recorder with an alarm system if the temperature rises to unacceptable levels.
- A FIFO or a plant specific rotation/inventory control system should be maintained for finished product.
- Doors on chillers and freezers should not be left open for extended periods and staff should be provided with protective clothing and trained to close doors immediately after opening.
- Refrigeration areas should not be loaded beyond their capacity (check with manufacturers) to ensure better air circulation around products.
- Wall, ceiling and floors of the chillers should be cleaned regularly, e.g. once a month.
- The temperature of the chillers should be monitored regularly, e.g. daily and recorded (see Table 5).

### Table 5 Monitoring of chiller or freezer temperatures

<table>
<thead>
<tr>
<th>Date and Time</th>
<th>Chiller 1</th>
<th>Chiller 2</th>
<th>Freezer 2</th>
<th>Comments</th>
<th>Initials</th>
</tr>
</thead>
<tbody>
<tr>
<td>20/10/02, 9 am</td>
<td>4°C</td>
<td>3.5°C</td>
<td>-18°C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Transport of wheat-flour noodles

The transportation of food that requires refrigeration is covered under Food Standards Code Standard 3.2.2 Food safety practices and general requirements. It is recommended that:

- Products should be brought directly from the chiller and placed in the transportation vehicle. If consignments are assembled in a staging area then refrigeration temperatures should be maintained in this area.
- Vehicles should provide effective refrigeration or other means of maintaining temperatures at equal to or less than 5°C, e.g. insulation, dry ice, cold packs.
- Where refrigerated trucks are used, wheat-flour noodles should be loaded into a precooled truck at, or colder than, the temperature of storage nominated on the label (usually 5°C).
- Refrigerated transport vehicles should have good air circulation around the product and should not be overloaded.
- The use of temperature recording charts or data loggers is encouraged to record the air temperature of the truck and/or the product during transport.
- The transport vehicle should provide a means of preventing contamination from other products by the use of cartons, shelves, dividers or crates.
- Any returned product should be clearly marked and segregated from other product.
Pest control program

Pests may include insects such as weevils and flies, animals such as rats, mice, and birds. They pose a major threat to the safety and suitability of food. Infestations can occur where there are suitable places for breeding and a supply of food. Good cleaning and storage of raw materials in pest-proof containers can control the supply of foods to pests. A regular pest control program should be in place, either in-house or contracted out to a reputable provider.

Whether pest control is carried out in-house or by a contractor, the premises, warehouses and all equipment should be regularly checked for signs of pest infestation to verify that the pest control program is actually working. The inspection results should be recorded and any corrective actions taken.

Any baits used should be well labelled, stored and laid where they cannot contaminate food, as they may be toxic to humans.

Product recall

You need a product recall program with documented procedures and you should give the program a 'dry run' to ensure it functions properly.

According to FSANZ Food Industry Recall Protocol, your recall program should contain, at a minimum, the following elements:

- documentation of product coding system and product identity,
- finished product distribution records that match the product coding system,
- a current list of people who will take part in any recall activities (including business and home phone numbers),
- step-by-step procedures in the event of a recall,
- means of notifying customers, retailers, wholesalers, etc.,
- control measures for the return of recalled product,
- means of ensuring the effectiveness of the recall,
- means of disposing of recalled product,
- means of coordinating recall with regulatory agencies,
- notification of the recall,
- follow up action(s).

You should notify regulatory authorities of a product recall, e.g. FSANZ, prior to the recall commencing. You should submit the following information: reason for the recall, amount of product involved, product codes, areas of distribution, contact person within the company, copies of any news release, etc.

Staff training

Personnel who are engaged in food operations, whether they come directly or indirectly into contact with food, should be trained and/or instructed in food hygiene to a level appropriate to the duties they will perform.

Food hygiene training is fundamentally important. All personnel should be aware of their role and responsibility in protecting food from contamination or deterioration. Food handlers should have the necessary knowledge and skills to enable them to handle food hygienically. Anyone involved in monitoring must also receive special training on how to carry out their tasks correctly. Those who handle strong cleaning chemicals or other potentially hazardous chemicals should be instructed in safe handling techniques for these chemicals, as well as how to make up the correct concentrations.

Training programs include:

- the importance of hygiene and how microbes, chemicals and foreign bodies affect food safety,
- the nature of the food, e.g. pH, water activity and its ability to permit the growth of pathogenic microbes,
- the importance of temperature control along with cooking, cooling and storage procedure instructions,
- the expected length of time before consumption and how this affects food safety,
- the importance of cross-contamination, especially post cooking contamination, and how it is avoided during handling and packaging,
- cleaning and sanitising instructions,
- personal hygiene,
- product recall,
- HACCP/Food Safety Programs, their development and implementations.

Records of training should be kept for each staff member. This may be just a note on their file to say they have been trained on the job to take a temperature reading. Periodic checks on the effectiveness of training and instruction programmes should be made. Training should be followed up by routine supervision and checks to ensure that specified procedures are being carried out.
2. Developing your HACCP-based Food Safety Program

What is HACCP?

HACCP is a systematic process of identifying, evaluating and controlling hazards in food production. It is product and process line specific, however several products may follow exactly the same process and have similar hazards associated with their raw materials. In such cases the products can be grouped into a product class and one HACCP-based Food Safety Program can be produced for the entire class. On the other hand, if similar products are produced using different steps and equipment, then each will require its own Food Safety Program.

How do I produce a HACCP-based Food Safety Program?

If you are manufacturing or you can demonstrate you can manufacture products that are safe, you do not have to follow the exact steps described here. You can continue the system you have currently in place.

Otherwise, you can work through the following 12 steps to develop your HACCP-based Food Safety Program

Step 1: Assemble a HACCP team

- In large companies the HACCP team may involve around six to seven people. In much smaller companies it is possible that only one or two people will be involved. No matter how large or small the team is, it is important for a senior manager to become involved. This not only demonstrates management support for the development of the HACCP-based Food Safety Program and influences its implementation, it also ensures that management is committed to providing the necessary financial and human resources. Often an operative from the process line has the best knowledge of what is going on and should be encouraged to participate in the team.

- The team must have overall knowledge about the process and product. Areas where expertise is needed include knowledge of the:
  - physical and chemical properties of the containers, raw materials, packaging used and an understanding of the hazards that may occur,
  - process involved in making the product, including the necessary cleaning steps,
  - machinery used in the process, such as its capacity, specifications, technical limitations and its advantages/disadvantages with respect to potential hazards,
  - product storage and distribution requirements and details of the distribution chain.

Some of this information can be obtained from your suppliers. Other areas of expertise may be needed during the study, and people with expertise in these areas can be called upon when required.

- A leader should be appointed and is usually responsible for the overall development of the plan. This leader should have sufficient knowledge to be able to direct the team in the HACCP principles and steps. Not every business has such a person and you may need to call in external help, especially when looking at hazards. However, if you work your way through the steps below you should be able to do most of the process on your own.

- The scope of the plan should be decided at this point. The scope summarizes what stages the plan will cover. Will it start at the entry of raw materials into the plant through to distribution, or only part of this process? Food Safety Programs for other products may already include a part of the process and it may not be necessary to include this again.
Step 2: Describe the products, processes and packaging

The product and processes should be defined in terms of:

- composition – ingredients,
- physical and chemical properties – any characteristics that might have an impact on product safety such as pH, water activity or potentially hazardous ingredients such as unpasteurised egg,
- any treatment applied to the product during manufacture which either kills microbes (e.g. cooking), controls microbial growth (e.g. refrigeration) and controls recontamination (e.g. covering during cooling),
- packaging requirements – the type and method of packaging,
- storage conditions – any special storage requirements such as storage at or below 5°C,
- method of distribution – the type of transport, whether it is refrigerated, insulated or at room temperature; potential for contamination during distribution; potential for damage to packaging.

Step 3: Identify the intended use of each product

Write a statement describing the typical use by the end user or consumer.

- It’s likely that you intend your product(s) to be consumed by all members of the public. However, some products like infant foods are targeted to sensitive individuals. In the population, the most vulnerable groups are the YOPIs (Young, Old, Pregnant and Immunocompromised) and they comprise about 20% of consumers. If you are supplying institutions such as nursing homes, hospitals or childcare centres with your products, you must take the sensitive nature of your consumers into account when doing your hazard analysis.
- If your product label stipulates that the product is intended to be cooked before consumption and gives instructions for cooking, this will lower the risk that a consumer will get sick. However, it does not necessarily make food safe because toxins that bacteria may have already produced in the food may still be active after cooking.

Step 4: Construct a flow diagram for each product

In this step you should cover all the production stages within the scope for each product. This might start at the time raw materials are received until the finished product is on the market, or it could cover a smaller part of the operation, depending on the scope. Number each step in the process. Information in the flow diagram should be as simple as possible but still describe the process involved. It can be useful to include:

- purchasing and receipt of raw materials, packaging and other inputs,
- storage of inputs – any special requirements, such as storage in a chiller,
- preparation details and process activities which may affect safety,
- any heating steps, recording temperature and time profiles,
- any product reworking,
- any variations in processing conditions at different times of the day (e.g. changed conditions during morning or night shift),
- storage,
- distribution steps.
In many cases several products will share the same early steps. Rather than repeating these steps for each product, you can draw a flow diagram for these common steps and refer to it in the flow diagrams for the different products.

An example of a flow diagram for Hokkien noodles is given in Figure 2. Your process is likely to be different and you should draw what is happening in your plant.
Figure 2 Example of a flow diagram of refrigerated Hokkien noodles containing egg

1. Receive raw materials in designated area

2. Store raw materials in designated area

3. Weigh ingredients, flour, salt

4. Thaw pasteurised egg at 0 - 4°C for 48 h

5. Mix all ingredients with water in mixer

6. Roll and sheet to 3 mm thickness

7. Rest for half an hour at room temperature

8. Cut to 2 mm width

9. Boil at > 98°C for 2 min

10. Oil

11. Cool in chilled running water bath (at 10°C) for 30 min

12. Drain for 1 h at room temperature

13. Store in chillers at less than or equal to 5°C

14. Package and label

15. Store noodles in chillers less than or equal to 5°C

16. Distribute at less than or equal to 5°C
Step 5: On-site confirmation of flow diagram

Once the flow diagram has been drawn, it must be checked in the processing area to ensure that it represents the process accurately. If you do not do this, you risk not identifying all the hazards in your process. This checking is best achieved by giving it to someone outside the HACCP team, ideally someone working in the processing area, and asking him or her to ensure that what appears on the flow diagram is what is actually happening, not what should be happening.

Step 6: Identify all hazards, conduct a hazard analysis and assess the risk

A hazard is anything in your product that may harm the person consuming your product. Hazards fall into three main classes, biological, chemical and physical hazards.

Biological hazards

Biological hazards include microbiological hazards, insects, birds, rodents and other unwanted animals that are sources of pathogenic microbes. Microbiological hazards include any pathogenic microbes, such as bacteria, moulds, viruses or parasites. Microbiological hazards can either be a direct hazard (i.e. they are present in the food), or an indirect hazard because they form toxins.

The hazard may be present because:

- pathogens are present on the raw material before it arrives at the plant,
- pathogens may contaminate the product at the plant before, during or after it is processed by cross contamination from other food, dirty water, dirty surfaces, dirty equipment, staff, and/or pests,
- pathogens may survive the processing step because of a failure to meet process requirements, such as the product not being heated to the correct temperature for a long enough time, or ineffective sanitation,
- pathogens may be given the opportunity to grow before, during or after processing because of time/temperature abuse, e.g. ineffective cooling,
- pathogens may contaminate the product through damage to the package,
- toxins may have been produced in the product.

Chemical hazards

Common chemical contaminants include:

- chemicals migrating out of packaging materials,
- cleaning chemicals. Contamination can usually be prevented by using non-toxic and food-grade chemicals, following manufacturer’s instructions, storing them appropriately and having written procedures in place for cleaning and sanitation,
- allergens in food products, including nuts, seafood, gluten, soy, cows milk and eggs. Presence of these ingredients causes severe distress in a small proportion of the population and can be life threatening. These individuals rely on labelling to screen foods containing allergens from their diets. Controls may be achieved by ensuring that the correct hygiene, sanitation and production procedures are followed to ensure that no unlisted food ingredient is added. If you use oil during oiling make sure you declare the type of oil on the label. Many people are sensitive to peanuts and peanut oil. Correct ingredient labelling is important.

Contamination by chemicals can occur throughout food production, processing and distribution, and may be a result of:

- contamination of ingredients before delivery, e.g. pesticide residues in flour, pollution contamination, contamination from packaging,
- contamination after delivery by cleaning chemicals, lubricants, vapours, addition of too high a level of a food additive.
• migration of chemicals from packaging materials.

Physical hazards
Physical hazards of concern in foods include glass, metal, stones, wood and plastic, and may be introduced into the food at any stage. Raw materials are a major source of these contaminants.

In your plant physical hazards can come from:
• untidy work areas and poor housekeeping,
• poorly maintained equipment,
• staff losing personal items from pockets or their bodies e.g. pens, rings, earrings,
• using packaging containers to store non-food items,
• poor cleaning practices,
• insects, vermin infestations.

Conducting the hazard analysis
Conducting a hazard analysis, where you look for all the things that could go wrong and compromise your product’s safety (quality issues are not considered here), will help you identify where you need to focus your efforts in keeping your product safe. The aim is to document all the hazards you can think of. Many will not be significant hazards, or will be controlled by other support programs and you will not need to address them in your HACCP plan. The hazard analysis records the controls you have in place for each hazard identified.

The hazard analysis involves three stages:

1. Examining each step identified in the flow diagram and determining whether there is a potential hazard.

2. Assessing the likelihood of any potential hazard(s) occurring at that step. As much information as possible on the hazard(s) needs to be gathered, and this may involve obtaining reference material about the hazard(s) and your product, including:
   • information from scientific books and journal articles,
   • information from suppliers, industry guidelines, any historical data available for your process or product that you might have collected.
   • results of any previous testing that has been conducted.

3. Identifying control measures to eliminate or reduce the hazard to an acceptable level.

Stage 1 requires that at each step of the flow diagram you need to consider if a hazard can arise due to the:
• raw materials,
• design of the plant and equipment,
• product properties such as pH or water activity,
• processing stage that is occurring such as a storage period or cooking step,
• personnel,
• packaging.

Once you have identified the hazards you will move on to stage 2. In this stage you decide how important it is to control each hazard. If it is important then you would call it significant. It is important that only significant hazards that are not controlled elsewhere by support programs are addressed in your Food Safety Program, otherwise there will be so many CCPs that it will become unworkable.
A good way to decide which hazards are significant is to look at the risk of the hazard occurring and if it occurs, how severe the consequences will be. Risk is a measure of the likelihood or chance that a hazard will occur, and severity is a measure of the effect on the health of the consumer. Injury is considered severe if the consumer could die or be left with a permanent disability, whereas a broken tooth may be considered a lower severity. Any hazard that is found to be real and significant must have a measurable preventative or control procedure associated with it. Risk assessment can assist in assigning priority for Critical Control Point (CCP) identification, and ensures that time is not wasted on hazards that are not significant.

In the third stage the preventive or control measure(s) associated with each hazard are listed against each hazard (Table 6). The preventive measure may already be in place in one of your support programs, such as a routine check and recording of cool room temperatures or cleaning and sanitising, but in some cases a new measure may need to be established. The preventive or control measure must be an activity that is measurable, e.g. temperature, time, pH and visual inspection.

The documented hazard analysis is useful because if an auditor disagrees with your CCPs, you can show them your reasoning for the decisions you took. It also provides a reference for current and future management decisions by staff who are not on your HACCP team.

Table 6 shows a few steps of a noodle manufacturing process as an example of what the completed form might look like; in your form you should show all the steps you have listed in your flow diagram.

Appendix 2 provides a more comprehensive list of potential hazards that could be encountered in the manufacture of refrigerated noodles, and some control measures.
Table 6  Example of a typical hazard analysis worksheet for the manufacture of refrigerated Hokkien noodles with egg

<table>
<thead>
<tr>
<th>Process Step No.</th>
<th>Type of hazard</th>
<th>Hazard &amp; Source/Cause</th>
<th>Likelihood</th>
<th>Severity</th>
<th>Significant hazard? (Yes or No)</th>
<th>Justification for decision</th>
<th>Control measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>BIOLOGICAL</td>
<td>Elevated levels of vegetative pathogens, such as <em>Salmonella</em> and <em>Staphylococcus aureus</em> which will not be inactivated by the manufacturing process</td>
<td>Low</td>
<td>High for vulnerable groups</td>
<td>No</td>
<td>Purchase only from approved suppliers. The presence of low numbers of vegetative pathogens is not considered a significant hazard because the product will receive a cooking process.</td>
<td>Supplier specifications, e.g. use pasteurised egg. Check and record if refrigerated perishable food is cool. Refrigerate within 15 minutes.</td>
</tr>
<tr>
<td></td>
<td>CHEMICAL</td>
<td>Toxic pesticide residues in raw materials</td>
<td>Low</td>
<td>Low</td>
<td>No</td>
<td>Purchase from approved suppliers.</td>
<td>Supplier specifications. Periodic supplier audits.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Presence of mycotoxins in cereal-based ingredients</td>
<td>Low</td>
<td>High</td>
<td>No</td>
<td>The risk of mycotoxin contamination of Australian cereals is very low.</td>
<td>Supplier specifications. Periodic supplier audits.</td>
</tr>
<tr>
<td></td>
<td>PHYSICAL</td>
<td>Plastic causing choking</td>
<td>Moderate</td>
<td>Low</td>
<td>No</td>
<td>Purchase only from approved suppliers who control the hazard. Inspection carried out by operators.</td>
<td>Supplier specifications. Monitor level of foreign bodies found on inspection. Sieving of flour.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Foreign objects causing injury</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>BIOLOGICAL</td>
<td>Pathogenic bacteria <em>e.g., Salmonella</em> may multiply in pasteurised egg if thawing or storage conditions allow</td>
<td>Low</td>
<td>High for vulnerable groups</td>
<td>No</td>
<td>Temperature storage conditions of egg are routinely monitored.</td>
<td>Ensure temperature of refrigeration where pasteurised egg is stored and thawed is at or below 5°C.</td>
</tr>
<tr>
<td></td>
<td>CHEMICAL</td>
<td>No hazards identified</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PHYSICAL</td>
<td>No hazards identified</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process Step No.</td>
<td>Type of hazard</td>
<td>Hazard &amp; Source/Cause</td>
<td>Likelihood</td>
<td>Severity</td>
<td>Significant hazard? (Yes or No)</td>
<td>Justification for decision</td>
<td>Control measure</td>
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<td>-----------------</td>
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<td>---------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>4.</td>
<td>BIOLOGICAL</td>
<td>Pathogenic bacteria <em>e.g. Bacillus cereus</em> spores, may germinate, multiply and produce heat stable toxins if temperature and time allow</td>
<td>Low</td>
<td>High for vulnerable groups</td>
<td>No</td>
<td>Egg is thawed in a refrigerator overnight. No vegetative pathogens should be present</td>
<td>Ensure temperature of pasteurised egg during thawing does not rise above 5°C</td>
</tr>
<tr>
<td></td>
<td>CHEMICAL</td>
<td>No hazards identified</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PHYSICAL</td>
<td>No hazards identified</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>PHYSICAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>BIOLOGICAL</td>
<td>Surviving <em>B. cereus</em> spores and other pathogens which may contaminate noodles after cooking may multiply if temperature rises</td>
<td>Low</td>
<td>Moderate</td>
<td>Yes</td>
<td>Cooking does not destroy <em>B. cereus</em> toxin or spores.</td>
<td>Monitor storage temperatures and keep at or below 5°C. Apply suitable ‘use-by’ date.</td>
</tr>
<tr>
<td></td>
<td>CHEMICAL</td>
<td>No hazards identified</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PHYSICAL</td>
<td>No hazards identified</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Approved: [signature]

Date: [date]
Step 7: Determine the Critical Control Points (CCPs)

A CCP is a step in the process where control of a significant hazard is necessary to ensure the safety of the end product. The CCP should strive to prevent, eliminate or reduce the hazard to an acceptable level.

Hazards that are considered to be significant should be tested to see if they are CCPs. In the short example in Table 6, only step 11 would be tested. To help identify your CCPs, the CCP decision tree (Figure 3) may be used in conjunction with the information obtained during the hazard analysis (Table 6) and the results recorded on Table 7. Not all significant hazards become CCPs, some hazards are controlled by support programs. You do not need to test hazards that are controlled by your support programs.

Your Hazard Worksheet may be slightly different from the examples presented but, providing it contains the same basic information, there is no need to change it.
<table>
<thead>
<tr>
<th>Process step/Hazard</th>
<th>Q1</th>
<th>Q1a</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>CCP? (Yes or No)</th>
<th>Team Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td></td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Storage of non shelf stable product</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Processing after cooking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Packaging</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Distribution</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Distribution</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Storage at retail</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Distribution</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Storage at retail</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Distribution</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Storage at retail</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Date:
Figure 3  CCP decision tree

Q1: Are preventive measures in place for the hazard?
   Yes
   No
   Modify steps in the process or product

Q1a: Is control at this step necessary for safety?
   Yes
   No
   Not a CCP
   STOP

Q2: Is the step specifically designed to eliminate or reduce the likely occurrence of a hazard to an acceptable level?
   Yes
   No
   Not a CCP
   STOP

Q3: Could contamination with identified hazard occur in excess of acceptable levels or increase to unacceptable levels?
   Yes
   No
   Not a CCP
   STOP

Q4: Will a subsequent step eliminate identified hazard or reduce likely occurrence to acceptable levels?
   Yes
   No
   Not a CCP
   STOP

Critical Control Point (CCP)

Step 8: Establish critical limits for each CCP

For each CCP identified, a critical limit must be set. The critical limit provides the boundary between safe and unsafe food. It must be realistic and directly related to the monitoring procedure. A critical limit should be linked to a measurable factor, e.g., pH, temperature and/or time.

Critical limits need not be the same as your operating limits. For quality reasons you may wish to use a stricter standard than that required for safety. This is called the 'operating limit' and can be anything provided it is more strict than the critical limit. For example, you may wish to cool within 2 hours rather than the 6 hour regimen found in Standard 3.2.2.
The critical limits set must be from a reliable source, which might include:

- published data – scientific literature, industry or regulatory guidelines. For example, Food Standards Code Standard 3.2.2 sets critical limits for product temperatures, e.g. refrigerated noodles must be stored less than or equal to 5°C,
- expert advice – consultants, research associations or other specialists such as cleaning chemical suppliers,
- historical data.

Remember to document the source of the critical limits in the HACCP plan so that you and others can check it at a later date. It is also important to update a critical limit as new information becomes available. Table 8 is an example of how you might record your critical limits.

**Table 8 Critical limit determination document**

<table>
<thead>
<tr>
<th>CCP</th>
<th>Critical limit</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCP 1: Storage of non shelf stable product</td>
<td>Temperature of noodles should never rise above 5°C</td>
<td>Food Standards Code Standard 3.2.2, sections on • Interpretation and application, • Temperature control</td>
</tr>
</tbody>
</table>

Approved: [Signature] Date: [Date]

You should summarise this information on a HACCP control chart (Table 9). This is a convenient document to show your customers when they ask whether you have a HACCP plan in place. Your HACCP control chart may be slightly different to the example presented but providing it contains the same basic information, there is no need to change it.
<table>
<thead>
<tr>
<th>Critical Operation</th>
<th>Hazard</th>
<th>Critical Limits</th>
<th>Monitoring</th>
<th>Corrective Action</th>
<th>Records</th>
<th>Verification</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCP 1: Storage of non shelf stable product</td>
<td>Post-process pathogenic contaminants and <em>B. cereus</em> able to grow</td>
<td>Temperature of noodles should never rise above 5°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
  - Temperature of finished goods in the chiller | Read temperature and record | General hand | If temperature of cool room rises above 5°C measure and record temperature of noodles, and move product to alternate storage. 
  - Product temperature may rise to 10°C for not more than 6 hours after which time it must be subjected to heat treatment (55°C for 20 minutes or equivalent), or discarded. 
  - If product temperature rises above 10°C for more than 6 hours, it must be discarded. | Batch sheet | Weekly check of records. 
  - Annual calibration of temperature gauge on chiller or when it malfunctions. |
Step 9: Set up monitoring procedures

The only way in which you know that your CCPs are in control is to monitor them. You should draw up a chart (see Table 10) which sets out the steps you need to monitor. This is the document you would keep on file to show the auditor what you are monitoring.

When setting up the monitoring procedures, several factors need to be considered:

- WHAT will be monitored, e.g. temperature,
- WHERE will monitoring take place, e.g. chiller,
- WHO will do the monitoring, e.g. food operative or supervisor,
- HOW the monitoring will be done, e.g. measured by thermometer,
- WHEN the monitoring will be done e.g. daily.

Table 10 Monitoring document

<table>
<thead>
<tr>
<th>What</th>
<th>How</th>
<th>Where</th>
<th>When</th>
<th>Who</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCP 1 Temperature in the finished goods chiller</td>
<td>Read temperature and record</td>
<td>Western wall of finished goods chiller</td>
<td>9 am and 5 pm</td>
<td>General hand</td>
</tr>
</tbody>
</table>

Approved: ___________________________ Date: ____________

On the factory floor there should be another chart to record what you are monitoring.

It might look like Table 11, which could be used to monitor the temperature of a cool room three times a day. Once these sheets are completed they should be stored as your record of cool room temperature.

Table 11 Cool room temperature monitoring record

<table>
<thead>
<tr>
<th>Cool room Number</th>
<th>Month</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Day</th>
<th>Time</th>
<th>Temp (°C)</th>
<th>Name</th>
<th>Time</th>
<th>Temp (°C)</th>
<th>Name</th>
<th>Time</th>
<th>Temp (°C)</th>
<th>Name</th>
<th>Comments/Corrective actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Step 10: Establish corrective actions for loss of control

No matter how well you prepare, something will always go wrong and in this step you decide what to do when (not if) things go wrong. There are two stages:

Firstly, fix the immediate problem. For example, if your cool room break downs, the first thing you do is to call the maintenance personnel. Then check the temperature of the noodles and decide whether they are still suitable for sale or whether they should be discarded.

Secondly, set up a strategy so it won’t happen again. For example, conduct regular maintenance and install an alarm to notify you if the refrigeration system breaks down or regas the chiller if this is necessary.

You need to identify:

- WHO will be responsible for taking the corrective action e.g. food operative, supervisor
- WHAT will be done with products which are ‘out of control’ e.g. discard product above a certain temperature.

Your documentation of corrective actions might look like Table 12.

<table>
<thead>
<tr>
<th>CCP</th>
<th>Fault</th>
<th>Immediate Action</th>
<th>Call</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCP 1: Storage of non shelf stable product</td>
<td>Temperature rises above 10°C</td>
<td>Measure and record the temperature of the noodles in the chiller</td>
<td>Maintenance. Shift supervisor. Discard product if temperature is &gt;10°C for more than 6 hours.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ensure no one enters and the door of the cool room is kept closed</td>
<td></td>
</tr>
</tbody>
</table>

The fault and corrective actions taken must be recorded and signed off by the person responsible. Table 13 shows an example of a corrective action record.

<table>
<thead>
<tr>
<th>CCP</th>
<th>Fault</th>
<th>Immediate Action</th>
<th>Call</th>
<th>Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Approved: 

Date: 

Page .... of .......
Step 11: Set up a system to verify and validate the HACCP plan

Verification must be included in the HACCP plan to provide assurance that the HACCP plan is operating as it should on a day-to-day basis.

The most common verification activity is an audit. An audit is a systematic examination to determine whether activities and results comply with the documented procedures; also whether these procedures are implemented effectively and are suitable to achieve the objectives. You might draw up a schedule like the example in Table 14.

<table>
<thead>
<tr>
<th>Section to be audited</th>
<th>Date for audit</th>
<th>Date audit conducted</th>
<th>Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw material storage</td>
<td>20th June 2003</td>
<td>20th June 2003</td>
<td>John Citizen</td>
</tr>
<tr>
<td>Packaging area</td>
<td>13th July 2003</td>
<td>13th July 2003</td>
<td>John Citizen</td>
</tr>
<tr>
<td>Cook section</td>
<td>20th August 2003</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raw material storage</td>
<td>10th June 2004</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Different kinds of audit may be used to confirm that the HACCP plan is being complied with and that it is effective. Both internal audits and audits by external parties may be included. Verification might also include microbiological testing to check that your products are not contaminated with pathogens of concern, i.e. Staphylococcus aureus and Bacillus cereus. A review of monitoring records, customer complaints, problems, corrective actions and follow up procedures are all verification procedures. Visual observation during production is also a way in which you can verify that the plan is working.

Validation refers to activities which confirm that the final HACCP plan has been correctly developed and provides control of all relevant hazards. Validation activities include a review of documentation used by the food safety team in establishing the HACCP plan, on-site confirmation of the process flow diagram, evaluation of identified hazards, and review of the hazard analysis to ensure that no hazards have been overlooked. Testing the noodle temperature during cooling to see that they cool as fast or faster than the requirements set out in Food Safety Standard 3.2.2. would be a form of validation. Microbiological challenge testing to ensure that pathogens won't grow during your process is another validation activity that may be used, but this tends to be expensive.

A HACCP-based Food Safety Program consists of the documents you prepare as you work through these steps. You can leave them on a computer, or print them out and put the sheets in a folder. But these must remain a living set of documents - that means they should be constantly reviewed and updated. Any change in your product line, process or ingredients should trigger a review.

Examples of changes that will make it necessary to review your system include:

- change in ingredients or ingredient sources,
- increased problems,
- change in factory layout,
- change in processing methods or equipment,
- change in cleaning procedures,
- change in packaging, storage or distribution conditions,
- change in consumer use,
- receiving any information on a new hazard associated with the product.
Step 12: Establish documentation and record keeping

Throughout these guidelines we have given you examples of forms that you could use in your Food Safety Program. You need to keep the resulting documents, monitoring forms and supporting records to show auditors and customers. In the event of a problem, they become legal documents, which support that you have operated with 'due diligence' and taken all reasonable precautions to avoid the hazards in manufacturing refrigerated wheat-flour noodles.

The documents and records you need are:

- the documentation or forms you generated when developing the HACCP plan itself,
- batch sheets or records,
- monitoring of times, temperatures and other processes,
- internal and external audit reports,
- calibration records for measuring equipment (scales, pH meter, thermometers, etc.),
- checklists,
- corrective actions,
- product specifications,
- support program documents and records.

It is not sufficient however, to collect data and just file the information. You must use the data by reviewing them daily, looking for trends which may indicate potential problems. Any problems should be investigated immediately.
Part 3:
Microbial contamination and pathogenic bacteria important in the manufacture of refrigerated wheat-flour noodles
Pathogenic bacteria important in the manufacture of refrigerated wheat-flour noodles

*Staphylococcus aureus* (*S. aureus*)

The name *Staphylococcus* is derived from the organism's appearance under the microscope – that of grape-like clusters. The most common type of *Staphylococcus* is *S. aureus*, which has a golden pigment (hence its common name “Golden Staph”). This organism causes boils and pimples; in pus there are very high numbers of the organism.

**Impact**

*S. aureus* has been responsible for one recall of noodles in Australia in 1997 (Table 1). In 1992, there was a *Staphylococcus* gastroenteritis outbreak in Canberra following a church lunch where noodles were consumed (Ciech et al. 1992). It has also been implicated in several outbreaks overseas associated with noodles.

**Infectious dose**

The organism makes toxins (poisons) that are released into foods. High numbers of *S. aureus* are needed before food becomes toxic. Illness occurs 0.5–6 h after ingestion of toxic food, which results in abdominal cramps, nausea and vomiting. Symptoms generally last for a few hours.

**Growth and toxin production by *S. aureus***

*S. aureus* grows at temperatures ranging from 7–48°C and can produce toxin between 10–48°C. Growth and toxin production can therefore be controlled by effective refrigeration. *S. aureus* will grow from pH 4–10, and can tolerate salt concentrations as high as 20%, or *a*<sub>W</sub> 0.83 under aerobic conditions. *S. aureus* does not grow well in the presence of other bacteria (*e.g.* in raw foods) however, it grows well in cooked, high protein, low *a*<sub>W</sub> foods such as ham, or high sugar foods such as custards, if the temperature and other conditions are favourable.

Table 15 shows those factors permitting growth and enterotoxin production by *S. aureus*.

**Table 15 Factors permitting growth and toxin production by *S. aureus***

<table>
<thead>
<tr>
<th>Factor</th>
<th>Growth</th>
<th>Toxin Production</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Optimum</td>
<td>Range</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>37</td>
<td>7–48</td>
</tr>
<tr>
<td>pH</td>
<td>6.0–7.0</td>
<td>4.0–10.0</td>
</tr>
<tr>
<td>NaCl</td>
<td>0.5–4.0%</td>
<td>0–20%</td>
</tr>
<tr>
<td>Water activity, <em>a</em>&lt;sub&gt;W&lt;/sub&gt;</td>
<td>&gt;0.99</td>
<td>0.83–&gt;0.99 (+O&lt;sub&gt;2&lt;/sub&gt;)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.90–&gt;0.99 (−O&lt;sub&gt;2&lt;/sub&gt;)</td>
</tr>
<tr>
<td>Atmosphere</td>
<td>Aerobic</td>
<td>Aerobic-Anaerobic</td>
</tr>
</tbody>
</table>

(From Stewart, 2003)

**Destruction of *S. aureus***

It is unlikely that very high levels of *S. aureus* will be present in the raw materials used to make noodles. Even if the bacterium is present, it is relatively easy to eliminate high populations by thorough heating
and cooking. Importantly, however, the toxins are resistant to digestion and heat, only being destroyed by prolonged boiling (>6 h). No heat treatment used in refrigerated wheat-flour noodle processing will eliminate these toxins, so their formation must be prevented. Therefore, it is important that once the noodles are cooked, all care is taken to ensure they are not recontaminated during cooling and packaging.

**Relevance for refrigerated wheat-flour noodle manufacture**

Staphylococci are carried by a large proportion (up to 40%) of healthy adults on the hands, nose, ears, mouth and skin, particularly in warm moist places. This means that food handlers can transfer the bacteria when they handle food. For this reason you should avoid contact of cooked noodles with bare hands. If hands are used they must be frequently washed (with soap), especially after leaving the packing table for any reason.

Operatives who have infected sores on their hands or body should not work in the processing area.

**Bacillus cereus (B. cereus)**

*B. cereus* is a bacterium that produces spores and an emetic toxin that are quite heat resistant and will survive most cooking processes. Before changes to handling practices, the consumption of fried rice often resulted in illness attributed to *B. cereus*, if the cooked rice was left at room temperature for a number of hours (often overnight) before frying. This enabled the *B. cereus* spores to germinate, grow to high numbers and produce toxins. Frying does not destroy the emetic toxin.

**Impact**

Historically, *B. cereus* has not been implicated in any recalls or foodborne disease outbreaks in noodles in Australia. However, it is a common contaminant of wheat-flour and therefore it is quite possible that such an outbreak could occur.

**Infectious dose**

The organism produces toxins (poisons) that can be released into the food (emetic toxin) or can be produced in the gut (diarrhoal toxin). For either syndrome, high numbers of *B. cereus* are required. The diarrhoal illness is characterised by abdominal pain and profuse watery diarrhoea, generally without vomiting. Illness typically occurs 10-13 h after consumption of the food and symptoms last between 12 and 14 h. The emetic syndrome occurs typically 1-5 h after ingestion, and is characterised by acute nausea and vomiting which last between 6 and 24 h.

**Growth of B. cereus**

Some strains of *B. cereus* can grow slowly at refrigeration temperatures (≥4°C); other non-sporulating strains grow from 8°C. The highest growth temperatures for *B. cereus* strains are 45-50°C.

*B. cereus* grows from pH 4.3 - 9.3, however the toxins are generally not produced in foods at pH < 6. Udon noodles are generally pH 6.5-7 and Hokkien noodles are around pH 9, so both products will support the growth of *B. cereus* if the organism is present, and storage temperatures allow.

** Destruction of B. cereus**

It is difficult to destroy *B. cereus* spores by the heating and cooking programs used in the manufacture of refrigerated noodles. Although the heat processes used will kill the vegetative cells, they are unlikely to destroy the spores.

**Relevance for refrigerated noodle manufacture**

*B. cereus* spores are very common in the soil, dust, cardboard and air. They are also often found in flour, in low numbers. This means that raw materials for noodle production can be contaminated, so care must be taken to prevent the germination and growth of *B. cereus* spores in moist noodle doughs before heating. Importantly, the diarrhoal toxin is heat sensitive but the emetic toxin is acid and heat resistant. Consequently, the heat treatment used in refrigerated noodle processing will not destroy any emetic toxin that might be present in the noodles.
Other pathogens

If you are manufacturing products other than refrigerated wheat-flour noodles on the same premises, you must consider the risks from other pathogens, *e.g.* *Listeria monocytogenes*, *Salmonella*, *E. coli*, etc.
Appendix 1:

Some information on basic microbiology
What are microbes?

Microbes are very small and generally can only be seen with the aid of a microscope. They differ in shape and size, and may reproduce rapidly if conditions are suitable.

The major groups of microbes are:

- algae,
- protozoa,
- bacteria,
- moulds,
- yeasts,
- viruses.

Algae

Algae are simple plants found mostly in water and damp soil. They are usually not a problem in foods, although they grow rapidly in water and may contaminate the water supply as algal blooms. They sometimes cause problems to humans if shellfish concentrate the toxins that some of these algae produce, resulting in illness.

Protozoa

Protozoa are small single cell animals. They mostly live in water, and some can cause disease in humans and animals. For example, *Giardia* and *Cryptosporidium* are protozoan parasites that affect humans through contaminated water and food. Food poisoning outbreaks due to protozoans occur rarely in developed countries. People infected with these organisms should not handle food.

Bacteria

Bacteria are single celled organisms and are widely distributed throughout the environment. Bacteria can exist in two forms – vegetative cells and spores. Vegetative cells tend to be easily killed by heat but spores may be quite resistant to heat, chemicals and other environmental conditions, such as low moisture. Not all bacteria form spores – generally only those that belong to the *Bacillus* and *Clostridium* groups. Spores are formed within the vegetative cells under adverse conditions, and when the spore is released, the cell dies.

Not all bacteria are bad; special types are used to good effect in the manufacture of cheese and yogurt. Most will grow on food, many may lead to food spoilage, and a few can cause food poisoning. When they grow to high numbers food spoilage bacteria cause changes in the sensory properties of foods, and usually the changes are unacceptable. In contrast, food poisoning bacteria do not produce changes to the appearance or taste of foods, so people don’t know they are there when they consume the food.

Food poisoning bacteria are called pathogenic bacteria or pathogens. Generally they cause illness by producing toxins (poisonous chemicals) that they either release into the food or into the (human) gut. Toxins formed in food cause vomiting, nausea and other symptoms soon after consumption, (around 1-6 hours), as the pre-formed toxins can pass rapidly through the digestive tract. The emetic toxins produced by *Staphylococcus aureus* and *Bacillus cereus* are heat resistant and cannot be destroyed by cooking. High numbers of organisms are generally required to produce enough toxin in the food to cause illness. Other foodborne pathogenic bacteria cause illness by reproducing and producing toxins within the gut, which then result in symptoms. This generally takes around 24-48 h, with diarrhoea being the predominant illness. For most organisms, high numbers are required to cause illness, however for others...
in particular environments such as some salmonellae and pathogenic *E. coli* in high fat or acidic environments, consumption of low numbers (< 10 cells) may be sufficient to cause illness.

**Moulds**

Moulds are usually multicellular organisms and are a common cause of food spoilage. Some moulds can produce toxins (called mycotoxins) that can be carcinogenic. Mycotoxins can migrate through foods, so removing the mould from the surface of a food might not remove the mycotoxins. Therefore, mouldy foods should be discarded.

**Yeast**

Yeast are single-celled microbes. They are usually larger than bacteria when viewed under a microscope, and may range in shape from oval to thread-like. Yeasts are used to ferment foods such as beer, wine and bread, but can also spoil foods.

At present, there is no illness directly attributable to yeasts in foods.

**Viruses**

Viruses are very small microbes and can only be viewed with special microscopes. They are parasitic and can only reproduce in host cells and therefore do not grow in foods but can often survive well there. They cause diseases such as hepatitis A when infected food is consumed. They are easily transmitted to or from food (e.g. from poorly washed hands, by coughing or sneezing), or from human to human and then to food. The infective dose for many viral illnesses is very low. People suffering from viral infections should not handle food.

**Sources of microbial contamination of foods**

Microbes are distributed throughout the environment – in the air, on our bodies and the bodies of animals, birds and insects, in soil and water, on equipment and surfaces, and in other foods.

Food is contaminated by contact with:

- dust, soil and water,
- food ingredients,
- humans and animals,
- pests,
- dirty equipment and surfaces.

Most raw materials are likely to be heavily contaminated with microbes if they have not been specially treated.

**Factors affecting the growth of microbes**

The growth of microbes is influenced by their environment, which includes nutrients, warmth (temperature), moisture, time, pH and the gas composition of the atmosphere around the organism.

**Nutrients**

Like all other living organisms, microbes require nutrients to grow, and these nutrients include carbohydrate, fat, protein, vitamins and minerals, which are present in many of the foods we eat. In most cases it is not possible to limit the growth of microbes by controlling the nutritional content of the food.
Temperature

Microbes can be classified into groups depending on the temperatures at which they will grow. Table 16 shows the temperature range at which different groups of microbes can grow.

<table>
<thead>
<tr>
<th>Group</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
</tr>
<tr>
<td>Thermophiles (heat loving)</td>
<td>40 to 45</td>
</tr>
<tr>
<td>Mesophiles</td>
<td>5 to 15</td>
</tr>
<tr>
<td>Psychrotrophs (cold tolerant)</td>
<td>-5 to +5</td>
</tr>
</tbody>
</table>

(From Adams and Moss 2000)

In general, reducing the temperature will slow the rate of growth of microbes. They will not grow in frozen food, but most of them will survive well in the frozen food, and be able to grow again when the food is thawed to a suitable temperature.

The Temperature Danger Zone is defined as temperatures between 5°C and 60°C. Perishable food should not be allowed to remain in this zone any longer than necessary.

Water activity ($a_w$)

Microbes require free water to grow. Within a food, water may be free or bound to food compounds like sugar or salt. Free water in food is related to, but different from moisture content. Free water in food can be measured, and it is referred to as water activity ($a_w$). The numerical values assigned to $a_w$ range from 0 (very dry) to 1 (water). The amount of free water present in a food will determine which microbes are likely to grow, as some are able to tolerate relatively low $a_w$ values and others require far higher values, closer to 1, for growth. Most microbes will grow in moist, fresh foods that have high water activity values (>0.95). Those capable of growth at low $a_w$ are more specialised. Table 17 shows the minimum water activity value at which some microbes will grow. If your products rely only on $a_w$ for safety from bacteria, the $a_w$ should be lower than 0.85. However, some microbes, including pathogens such as Salmonella and Escherichia coli, can survive for a long time in dry foods with low $a_w$.

<table>
<thead>
<tr>
<th>Group of microbes</th>
<th>Minimum $a_w$ (scale of 0-1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most bacteria</td>
<td>0.90-0.95</td>
</tr>
<tr>
<td>B. cereus</td>
<td>0.91</td>
</tr>
<tr>
<td>S. aureus</td>
<td>0.83</td>
</tr>
<tr>
<td>Most yeasts</td>
<td>0.75</td>
</tr>
<tr>
<td>Most moulds</td>
<td>0.70</td>
</tr>
<tr>
<td>Salt-tolerant bacteria</td>
<td>0.80</td>
</tr>
<tr>
<td>Very low moisture-tolerant moulds</td>
<td>0.61</td>
</tr>
</tbody>
</table>
Time

Microbes need time to adjust to the environment before they start to grow. This is known as the lag time and it varies according to the organism and the conditions. Once this lag time is over, growth can be very fast if conditions are right. In food processing we want to lengthen this lag time, to make it as long as possible. Bacteria reproduce by a single cell dividing into two cells. During the growth period this can happen every 15-20 minutes or less for some bacteria under conditions (temperature, pH, nutrients) that are optimal. This means that if bacteria can double every 20 mins, then starting with 1 cell, after 4 h there will be over 4,000 cells, and after 6 h there will be nearly 300,000 cells, under optimal conditions.

pH of the food

The term ‘pH’ gives a numerical value (ranging from 0-14) of the acidity of the food. The more acidic the food, the lower its pH, or the closer the number will be to 0. Most bacteria will grow best at pH values around 5.8-7.5. In general, moulds and yeast will grow at lower pH values than bacteria, and spoilage bacteria will generally grow at lower pH values than food poisoning (pathogenic) bacteria.

The pH of the food is measured using a pH meter, which needs to be calibrated before use. Regular (e.g. daily) calibration of your pH meter is part of GMP and gives you confidence that your meter is reading correctly.

Gas atmosphere

Microbes can be classified into four groups based on their oxygen requirements, as shown in Table 18.

<table>
<thead>
<tr>
<th>Group of microbes</th>
<th>Oxygen requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerobic (e.g. most Bacillus, most moulds)</td>
<td>Require oxygen to grow</td>
</tr>
<tr>
<td>Anaerobic (e.g. Clostridium)</td>
<td>Require the absence of oxygen to grow</td>
</tr>
<tr>
<td>Microaerophilic (e.g. Lactobacillus, Campylobacter)</td>
<td>Grow best in the presence of small amounts of oxygen. May or may not grow in air.</td>
</tr>
<tr>
<td>Facultative anaerobic (e.g. Salmonella, Listeria)</td>
<td>Will grow in the presence or absence of oxygen</td>
</tr>
</tbody>
</table>

The type and concentration of gases present in the packaging around the food will affect the types of microbes capable of growing in that product. Packaging in the absence of air, i.e. vacuum packaging or in modified atmospheres (also known as gas flushing), can be used to extend the shelf life of some foods. However, this should be done with caution because some pathogens prefer these conditions to grow.

One of the important results of gas flushing and vacuum packing is that the bacteria and moulds that cause spoilage are often unable to grow and the product looks as if it has a longer shelf life. However, the growth of pathogens generally does not change the look, smell or taste of food: although the food may look perfectly fresh, it may contain enough pathogens to cause illness. If you are using gas flushing you must be aware of this and you should carry out a challenge test to validate the safety of your product throughout its shelf life.
Appendix 2:
Potential hazards that may be encountered in the manufacture of refrigerated noodles
Table 19 Potential hazards and control measures to be used in the manufacture of refrigerated noodles

The following table lists some of the potential hazards you may encounter in your business. This list is not inclusive and the hazards will vary from one business to another. Many of these hazards can be controlled by implementing effective support programs.

<table>
<thead>
<tr>
<th>Potential hazard</th>
<th>Method of control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microbial contamination of noodles by using unpasteurised or cracked whole eggs in the formulation.</td>
<td>Use only pasteurised egg and train staff to handle such products hygienically.</td>
</tr>
<tr>
<td>Incorrect thawing may allow spores to germinate e.g. <em>Bacillus cereus</em> and the cells may then grow and produce a heat stable toxin.</td>
<td>Thaw under controlled conditions between 0 and 5°C.</td>
</tr>
<tr>
<td>Addition of undeclared egg because rework dough, containing egg, is added to non-egg containing products.</td>
<td>Label rework with the product it was destined for and use only in that product.</td>
</tr>
<tr>
<td>Cross contamination of cooked noodles from raw noodles.</td>
<td>Never let cooked noodles come into contact with raw noodles.</td>
</tr>
<tr>
<td></td>
<td>Have separate areas for dough preparation, raw noodles, cooking, cooling and packaging of cooked noodles.</td>
</tr>
<tr>
<td></td>
<td>Have an effective GHP program in place, train staff on the importance of keeping raw and cooked product separate.</td>
</tr>
<tr>
<td></td>
<td>If necessary, packaged cooked and raw noodles can be stored in the same location.</td>
</tr>
<tr>
<td>Cross contamination of cooked noodles from the environment or poorly cleaned equipment.</td>
<td>Minimise contamination from the environment and within the plant by adopting GMP and staff training.</td>
</tr>
<tr>
<td></td>
<td>Monitor that GMP is being followed.</td>
</tr>
<tr>
<td>Cross contamination of cooked noodles by poor hygiene practices.</td>
<td>Train staff in GHP and monitor.</td>
</tr>
<tr>
<td></td>
<td>Provide sufficient washbasins, soap, towels, clean uniforms and facilities to make it easy for staff to follow GHP.</td>
</tr>
<tr>
<td>Pathogens surviving cooking inside noodle strands.</td>
<td>Monitor the cooking process. Ensure product reaches 76°C.</td>
</tr>
<tr>
<td></td>
<td>Ensure staff are trained to follow instructions on cooking noodles.</td>
</tr>
<tr>
<td></td>
<td>Ensure staff understand how important effective cooling is in preventing growth of pathogens.</td>
</tr>
<tr>
<td>Contamination of cooked noodles during chilling.</td>
<td>Ensure GMP is in place and the water used is free from pathogens.</td>
</tr>
<tr>
<td></td>
<td>Ensure that there is a constant overflow to waste and fresh chilled water is added constantly.</td>
</tr>
<tr>
<td>Issue</td>
<td>Control Measure</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Cooling noodles too slowly and allowing <em>B. cereus</em> spores to germinate and grow, and possible toxin production.</td>
<td>Ensure cooling is rapid, within the times specified in the Food Standards Code Standard 3.2.2, i.e. the noodles should reach 5°C within 6 hours. You may need to purchase rapid chilling equipment to achieve this.</td>
</tr>
<tr>
<td>Cross contamination from raw noodles or from other products during storage of unpackaged cooked noodles in the cool room.</td>
<td>Ensure an effective cleaning and sanitation program. Have dedicated chill storage for cooked noodles, which is separate from that used for other products until noodles are covered or packaged. Provide covers for all products.</td>
</tr>
<tr>
<td>Storage of cooked noodles at greater than 5°C allowing the growth of pathogens.</td>
<td>Monitor cool room and transport temperatures. Have corrective actions documented in the event of a cool room failure. Train staff in how to monitor and implement corrective actions.</td>
</tr>
<tr>
<td>Cross contamination with pathogens from workers’ hands during manual packing of noodles.</td>
<td>Use gloves and implements to handle noodles where possible. Ensure staff are trained in GHP, wash their hands and change their gloves frequently.</td>
</tr>
<tr>
<td>Contamination of noodles through poor seals or perforations in package.</td>
<td>Ensure correct packaging material is used and heat seals are adequate.</td>
</tr>
<tr>
<td>Labelling not sufficiently specific to alert consumers who have food allergies.</td>
<td>Ensure label states that the product contains • wheat flour (i.e. gluten) • egg • peanut or other oil where appropriate.</td>
</tr>
<tr>
<td>Temperature during transport rises above 5°C for long enough so that the total time cooked noodles are at these temperatures is greater than 6 hours.</td>
<td>Load noodles at or below 5°C into precooled vehicle at or below 5°C, or pack with cold packs or dry ice into insulated containers. Avoid excessive delays in loading, unloading and removal to refrigerated storage.</td>
</tr>
<tr>
<td>Returned product is sent out with fresh product without confirming that it is still safe.</td>
<td>Have a system for labelling and segregating returned product.</td>
</tr>
</tbody>
</table>
Glossary

Audit: An audit is a systematic and independent examination to determine whether processes and results comply with the documented procedures; also whether these procedures are carried out effectively and are suitable to achieve the objectives.

Clean: Means clean to touch and free of extraneous visible matter and off-odour.

Contaminant: Means any biological or chemical agent, foreign matter, or other substances that may be present in food and affect its safety or suitability.

Contamination: Means the introduction or occurrence of a contaminant in food.

Control (noun): Where correct procedures are being followed and criteria are being met.

Control (verb): Take all necessary actions to make sure correct procedures established in the HACCP program are being followed.

Control measure: Any action and activity that can be used to prevent or eliminate a food safety hazard or reduce it to an acceptable level.

Corrective action: Any action to be taken when the results of monitoring at the CCP indicate a loss of control.

Critical Control Point (CCP): A stage or point in the process at which control can be applied and is essential to prevent or eliminate a food safety hazard or to reduce it to an acceptable level. Loss of control at this point could pose a risk to the health of the consumer.

Critical limit: The numerical value of a process parameter (e.g. a temperature), which separates what is acceptable from what is unacceptable.

Equipment: Machinery, instruments, apparatus, utensils or appliances, other than single-use items, used in connection with food handling, including any apparatus used to clean food premises or equipment.

FIFO: First in, first out.

Flow diagram: A representation of the steps or operations used in the manufacture of a particular food item.

Good Hygiene Practice (GHP): GHP is a set of policies on clothing, staff hygiene, illness, smoking, eating, waste bins and stock rotation.

Good Manufacturing Practice (GMP): GMP is a set of procedures that ensure that the building(s), equipment and staff operate in a manner which minimise product contamination with microbes and other extraneous materials. Procedures cover building design and the condition of the surroundings, operation, cleaning and sanitation, equipment maintenance, waste disposal, pest control programs, personnel and training.

HACCP: A system which identifies, evaluates and controls hazards which are significant for food safety.

Hazard analysis: The process of collecting and evaluating information on the hazards and conditions that may lead to the presence of hazards, and identifying which ones should be dealt with in a HACCP plan.

Hazard: A hazard is a biological, chemical or physical agent (in food) with the potential to cause harm to the consumer. This can include bacteria, toxic chemicals, foreign objects, etc.

Monitoring: includes checking, observing or supervising in order to maintain control. If you are monitoring CCPs, you are checking whether the hazards are being controlled (whether there are any deviations) so that you can decide if corrective actions are necessary.

Operating limits: Critical limits are required for safety and are recorded in HACCP plans. In practice, higher limits are often used for quality reasons and these are called operating limits.
**Pathogen:** Microbe that can cause disease, such as a bacterium or virus.

**Pests:** Include birds, rodents, and insects.

**Potentially hazardous foods:** Foods that will support growth of pathogenic microbes or might be a source of foodborne illness.

**Risk:** The likelihood that a hazard will actually occur. There are different levels of risk. You might run into your garage wall when you get home, but the risk is fairly remote. On the other hand you could have a car accident on the way home, a much more likely risk.

**Risk assessment:** Tries to estimate the likelihood of a hazard occurring and the severity of the hazard should it occur. This is where you will probably need expert assistance.

**Severity:** Severity defines the seriousness of the hazard and its consequences. If you are a healthy adult, a hazard such as food poisoning by *Salmonella*, is much less severe than if you are an elderly person with a chronic illness.

**Signed off:** By signing the document, you are taking the responsibility that you have checked and approved a record as a true record of what has happened.

**Single-use item:** Means an instrument, apparatus, utensil or other item intended by the manufacturer to be used only once in connection with food handling. This includes disposable gloves.

**Spoilage organisms:** Microbes (yeasts, moulds or bacteria) that can grow in foods and induce changes that spoil the food or make it unappetising, due to colour, aroma or flavour changes. Although rendering the food unacceptable, they generally do not cause illness.

**Validation:** Obtaining evidence that the HACCP plan is effective. This is usually done by an audit process.

**Verification:** The application of methods, procedures, tests and other evaluations, in addition to monitoring, to check that the HACCP plan is working.