The thermometer is the most misunderstood tool in the cold chain
by Mark Mitchell, Chairman of the Australian Food Cold Chain Council

Having forecast in the last issue (*Cold Chain training starts with the simple things)* that the humble thermometer will be the target of a new training initiative for cold chain practitioners, here's a small taste of the training course that might satisfy those who ask 'What's there to know about a thermometer?'.

The course is now live on the website of the Australian Food Cold Chain Council (https://afccc.org.au/training.html) and other membership organisations will add the training to their websites soon.

Called the Cold Chain Professional Development Series this course is just the beginning of a concerted campaign by the AFCCC to lower the country's quite serious food loss and wastage figures. There are four more codes to be written, with accompanying training modules covering the entire cold chain including all facets inbound and outbound from the grocery and retail environment.

The AFCCC is charging a low fee for the online thermometer course which will go towards funding the work on the other codes.

Leading players in Australia's fight against food waste have applauded the initiative. The respected special adviser to the Fight Food Waste CRC, Mark Barthel said of the online training modules, '*...a great job of encapsulating all of the information required for a practitioner to understand the importance of an integrated cold food chain and the use of the most appropriate thermometer technology*'.

The training is aimed at two audiences – the cold chain practitioners, those who work at the coalface of the cold chain and most likely to need thermometers in their hands, and managing practitioners, who are responsible for overseeing a compliant critical control point and ensuring that the right thermometers are used and understood for the job at hand.

The training modules go back to the basics of what a thermometer does, and the technologies they use to convert resistance changes into a numerical value.

There are seven main technologies in common use in the cold chain – thermistors, thermocouples, resistive temperature detectors, infrared

thermometers and bimetallic devices. These technologies are applied across four types of thermometers – probe, infrared, time temperature recording devices and single use temperature indicators.

The Code spells out the advantages and disadvantages of each, plus their response speed, sensitivity and stability.

Before a thermometer of any kind is even switched on (or perhaps even purchased) the practitioner must determine a number of things if the plan is to arrive at an accurate temperature of any product.

For the thermometer itself, they first need to know the thermometer speed, its accuracy and its ease of use for the intended job.

All chilled or frozen foods have their own safe temperature specifications, so when selecting a type of thermometer, a cold chain practitioner needs to understand these parameters:

- type of food being carried
- type of packaging – bulk on pallets, in boxes, cling-wrapped
- state of the food – chilled or frozen
- target temperature – centre or surface
- measurement accuracy and response time
- thermometer sensor stability over a period of time
- ease of use and cost effectiveness.

The ideal thermometer should:

- Reach 90% of final reading in less than three minutes
- have less than ± 0.5°C accuracy at –20°C to 30°C temperature range
- change by no more than ±0. 3°C when operated at –20°C to 30°C temperature range
- have at least one digit after the decimal point on the display reading
- be robust, shockproof and waterproof
- be easy to clean and allow good thermal contact with the tested food
- be operated by a dry cell battery and have a means of warning when the battery needs replacing
- suit the target measurement (for example, robust rigid stem with a sharpened point for insertion into product, and a flat head for between-pack measurements.

Depending on the accuracy required, the next decision must be whether a destructive or non-destructive measurement can be taken.

The non-destructive method, using either a probe or infrared thermometer only measures the surface temperature of chilled or frozen products, and that may not give an accurate reading of the core temperature of foodstuffs.

The successful use of a probe relies on excellent surface contact between the probe and the item being measured. Even shapes and sizes of probes will be different if inserted between boxes on pallets, or loose packages.

With the destructive method, a pointed probe thermometer is inserted into the product or pressed firmly into its side. This method is considered the best and most accurate for measuring the temperature of non-bagged products.

This measurement method is also the only way load rejection and potential liability claims can be avoided, provided that the probe thermometer used has proven calibration, accuracy and limitation tolerances.

If temperatures are regularly measured in a single-product environment, an infrared thermometer can be used, but a knowledge of emissivity value is needed. It's not as simple as buying any infrared thermometer and expecting a valid reading by just pointing and shooting. A reflective surface on a produce box or package will also give a false reading.

An infrared thermometer cannot see through glass, liquids or other transparent surfaces. If pointed at a window, it will measure the window pane temperature. The visible laser beam emitted by these thermometers is purely an aid for aiming – it is not measuring anything. It shows the centre of a measuring spot, which emits the infrared energy that is measured by the thermometer to arrive at a temperature reading. The size and coverage of that spot is critical to accurate temperature measurement.

The energy is measured as emissivity, which is expressed as a value – from 0 for a mirror, to 1.0 for a black surface. The emissivity value of most unpackaged foods is in the 0.9 to 0.95 range, but if the food packaging has a reflective surface an accurate temperature cannot be taken unless steps are taken to artificially darken the surface of the packaging.

If your workplace manages one product type only, an infrared thermometer can be selected with an emissivity value suitable for the measurement of that product. The emissivity value will be preset at the time of manufacture, and cannot be changed.

But for cross-docks that handle a variety of food products, in a variety of packaging, and at varying temperatures an infrared thermometer with user-adjustable emissivity must be used.

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