

Don't kill your customers.

A practical guide to monitoring temperature

Saving lives and business

There are some things that a business can not afford to lose. Money is an obvious one, but what about a good reputation? What about the life of a customer? Lose any of these and your business won't be around for much longer.

For most companies this is enough incentive to provide a safe business environment. The law, however, is changing and is increasing the standards. These laws provide strict requirements when handling potentially dangerous food. The principles, however, can be applied to any perishable item.

Finally customer expectations are increasing. Freshness can not be compromised. Shelf life is another issue. In the end your product must be the best because people don't want anything less.

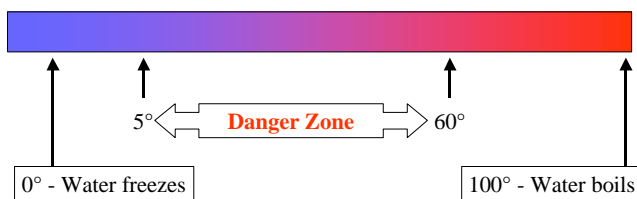
Key temperatures

There are a number of temperatures that play a key role within the food industry. The obvious ones are 0° and 100°. After all, the drinks need ice and the tea has to be hot. 22 to 24° is the ideal room temperature.

5° and 60° have been specified within the Australian New Zealand Food Standards Code as being the range in which microbiological growth can occur. This is the danger zone. If food is left too long within this temperature range then potentially deadly micro-organisms can grow.

Heating food above 60° will kill the microorganisms. It will not, however, remove the toxins that may have been introduced. Cooling food to below 5° will almost stop the growth of microorganisms.

The Foods Standards Code states that if you are receiving, storing, processing (including defrosting and preparing), cooling, reheating, displaying and transporting potentially hazardous foods then you must be able to prove that you have not exposed the food to this critical temperature range for too long.



Thermometers and temperature loggers

Many people will already be using thermometers within their business but they provide very little information. Just because the temperature is right now does not mean that it was always right. A min/max thermometer will tell you if it has been outside the temperature limits but not for how long or why.

This is where a temperature logger becomes an invaluable tool. They can save you time, money and your reputation. They give you the ability to monitor an item even when it is outside your control and to identify when problems occur. They work 24 hours a day, seven days a week.

Capabilities and applications

A temperature logger records the date, time and temperature at regular intervals. The results can then be displayed at a later time.

A temperature logger can tell you when excessive temperatures were reached, for how long it stayed at that temperature and if it happened multiple times. It can also show the average temperature and cycles in temperature.

Temperature loggers have been used to monitor refrigerators and freezers for many years now. They can also be used for display and serving areas. This provides critical information on how your *equipment* is operating.

There is also a rapidly growing demand to monitor individual pallets or boxes. This then allows the user to detect if the product has been left out of the refrigerator or freezer, when and for how long. It provides critical information on how your *operating procedures* are being followed.

If you are involved with the transport of food then temperature loggers can now stay with your products from start to finish. On one side, temperature loggers are now being used to monitor everything from beef, pork, chicken and sea food to fruit, vegetables, nuts and berries to milk and dairy products to frozen products. On the delivery side temperature loggers are monitoring caterers, deliveries and mobile food stalls.

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The benefits of temperature loggers

Find the cause

Since the time and date are recorded it is possible to tell when temperatures occurred. From this it may be possible to determine who was in possession of the item, or who was working at the time. This information can then be used to help place the responsibility on the correct party or fix the problem. Ultimately it can help stop the problem occurring again.

An exporter discovered that his goods had been left on a tarmac for a number of hours in a tropical country. The temperature logger clearly indicated when it occurred and for how long. In this case it was possible to place the liability but it also meant that the problem could be addressed to stop it happening again.

Not all cases are this easy. With no supporting proof, however, it is nearly impossible to force a company to accept responsibility for spoilt items and fix the problem.

Save money

The shelf life of many items is temperature dependent. Maximise shelf life by ensuring items are always at the right temperature. One catering company profiled a fridge and discovered a temperature variation of a couple of degrees from top to bottom and front to back. This information then allowed them to change the location of item.

Improve your reputation

People will only talk about you if you provide a bad product or an exceptionally good one. Temperature loggers will help in stopping the bad food from reaching the customer. It is then up to you to make the exceptionally good product.

A catering firm could place a temperature logger with items being sent out of the kitchen. The staff can test the item temperature before it is served. The information could also be stored in case there were any complaints.

But is it all good news?

Unfortunately not. Temperature loggers can introduce problems. Loggers typically provide information after the event. It is no good knowing that a fridge was too hot a week ago when food has already been sold. In many cases a thermometer or logger with temperature display should be used so that the staff can check the temperature at any stage.

The other problem is that the staff may become complacent and rely upon the loggers to automatically do their job. Staff should always feel responsible for maintaining the quality of goods. The loggers are there to provide proof that existing systems are working or to measure temperature when no staff are present.

Selecting the right temperature logger or thermometer

Following are the main features that you should be aware of when comparing temperature loggers. Many of the features apply to thermometers.

Resolution

The resolution is an indication of how specific the answer is. It is measured in degrees. The smaller the value, the better the device.

For example, a resolution of 0.5° means that a reading of 3.5° could be between 3.25° and 3.75°. A resolution of 0.1° means that a reading of 3.5° could be between 3.45° and 3.55°.

The maximum permissible resolution depends upon the application. For example, when monitoring body temperature it is critical to have at least 0.1° resolution. For food this degree of resolution is often not necessary. The change in temperature that has to be recorded is a couple of degrees and a resolution of 0.5° is often acceptable.

Accuracy

The accuracy indicates how close to the actual temperature a reading is. The smaller the number, the better the device. The current HACCP requirement in the food industry for accuracy is typically 1°C.

The difference between accuracy and resolution can be seen in this simple analogy.

Two men have a watch. One watch shows the hours, minutes and seconds. It has a *resolution* of 1 second. The other watch only has hours and minutes. It has a *resolution* of 1 minute.

The first man sets his watch once a month and it can be up to 5 minutes fast or slow. It has an accuracy of +/- 5 minutes. The second man sets his watch daily and has an *accuracy* of 1 minute.

In this example, the first man could state the time as "1:34 PM and 23 seconds" but could be up to 5 minutes out. His answer is specific (good resolution) but inaccurate. The second man can only say the time is "1:36 PM" but will be within one minute of the time. His answer has a lower resolution but is more accurate.

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Sources of errors

It should be noted that the accuracy is dependent upon a number of factors. They are:

1. The instrument: The device itself will cause errors because of limitations in digital processing and physical issues (eg "cold junction compensation" with thermocouples).

2. Sensor: The sensor is often the greatest source of error in the reading. It is also difficult to compensate for sensor errors. It requires that only sensor ever be used with the instrument and that it be used at a certain temperature. Thermistors and PT100s are interchangeable within 0.4°. Thermocouples, however, have much larger errors. Type K can have errors up to 2.2° and 1° for type T. Special tolerances can reduce the Type T's errors by half and make them acceptable for use with food. **Type K should never be used with food.** They are outside the 1° accuracy required.

Note that the accuracy required is the total of the instrument and sensor error. For example, if an instrument has a 0.4° error and a sensor has a 0.8° error then they are not acceptable because the total is 1.2° error.

Many devices fail because they have an accuracy of 1° plus a percentage error of the reading (eg 1° +/- 3% of reading = 1.3° at 10°). It is the total possible error that is important in determining if a system complies with the standards.

3. Measurement error: This is difficult to predict and depends upon the skill of the operator as well as what they are trying to measure. Using the wrong device will produce a false reading. For example an infra-red thermometer measures surface temperature only. The temperature within the item could be significantly different.

Construction

Like most items, temperature loggers break. Consideration should be given to the robustness of the logger if it is to be transported or regularly moved. Stainless steel loggers are available. Most loggers are plastic

Water resistance is another feature that should be considered if the logger is to be used in a wet or dirty environment. Water damage is a common occurrence. Within the food industry it is strongly recommended that water-resistant loggers be considered.

Size

Loggers vary in size from the size of a coin to large rack mounted machines. For the larger sized units there is typically a probe that will be inserted into the area to be monitored.



Battery life

Most units have replaceable batteries. The battery life should be noted. If it is too short then you will be continually replacing batteries and you could also be losing data mid-journey.

Starting options

Temperature loggers often offer a range of techniques to start the logging. A start delay is useful for programming loggers prior to usage. They can then be sent to the user or picked up later.

A trigger is another handy feature. For example, when the temperature reaches 6° then start logging. This means that memory is not being used while it is within the correct temperature range but will start as soon as extreme conditions occur.

Remote starting devices are also available for many loggers. These devices allow a person to start the logger without a computer.

Number of inputs

There are a number of single point loggers on the market. These devices record either their surrounding temperature or have a remote probe. They are very useful for monitoring individual trucks or items.

Larger units provide for multiple probes. The benefit is that there is only one unit that has to be connected to a PC. Retrieving the data is quicker and simpler. The installation is more expensive and difficult because cables have to be run from the probe back to the logger but once installed it saves time.

Outputs

Some loggers provide a display so that the current, minimum and maximum temperatures can be displayed. Indicators for alarms are also available on some units. A relay output is also available. This allows an external alarm to be activated if the temperature becomes too high or low. These options will typically increase the price of the logger. There are also dedicated devices that can also achieve these functions.

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Sample rate

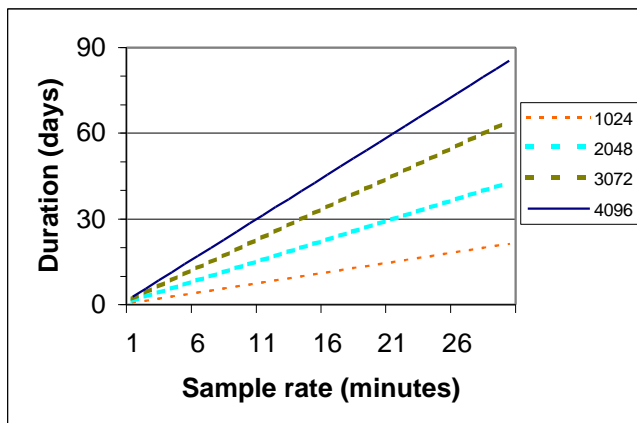
This is how often the logger will record the temperature. For transport and storage applications a sample rate of between 1 and 30 minutes is typically required. When processing items sample rates down to 1 per second could be required.

If the sample rate is set too slow then it could possibly miss an event. For example, if it is set to 30 minutes then it could miss a 15-minute rise in temperature. If it is too fast then it will consume more memory and the results will take longer to check.

Memory

The total number of samples the logger can record is critical. It determines the fastest sample rate that is possible for an application. Once the memory is full the logger will either stop or write over the oldest readings. Either way information is being lost. The larger the memory, the better the device.

The maximum time the logger will record is the sample period times the memory size. The following graph shows the duration of a logger with the sample rate set between once a minute to once every 30 minutes. Four different memory sizes are displayed.



For example, an item is to be transported for 30 days. A unit with 2048 readings memory could sample with a period of 22 minutes. It is decided that a sample period of 15 minutes is required. A unit with at least 4096 readings is required.

Software

The great benefit of loggers is the ability to view the results and save them for later use. Each logger will typically have its own software. They vary in what the software can do and how easy it is to use.

One product on the market has two versions of software available. One provides a powerful database engine with flexible reporting capabilities. The other version has the same data display capabilities but is much simpler to use. For many customers the second version is the better option. It takes 2 minutes to learn and does everything that they

require. So when testing software, first decide what you require and then test to see how hard it is to achieve.

Probes

Selecting the right probe is as important as selecting as selecting the right device. Many of the principles discussed apply directly the probe. Of particular importance are:

- ? Temperature range and accuracy
- ? Speed of response
- ? Robustness
- ? Shape
- ? Ease of use

There is now a wide range of probes available. Custom probes can also be manufactured by a number of companies.

Price

The biggest issue for many people is price. Reusable temperature loggers range in price from about \$60 to thousands of dollars. Money can be saved by not over specifying what is required and by shopping around. Recent technology has allowed improved devices to be made for less so paying more does not necessarily mean better.

Summary

If you store, transport, process or sell temperature sensitive items then temperature loggers can save you money, time and even your reputation. They are becoming increasingly popular due to falling prices but also increasing demands to sell quality products.

Don't let failing equipment or procedures give your business a bad name. Save time, money and your reputation by investing in a temperature logger.

The check list:

Required temperature range:

Required accuracy:

Required resolution:

Water resistant:

Length of run:

Sample rate:

Memory (= length of run / sample rate)

Display options:

Output options:

Physical size:

Number of inputs:

Starting method:

Reading method:

Construction: