# Better & Faster: The Internet of Things Re-invents Food Safety Management for Food Service Operators

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## Summary

- Internet of Things technology is poised to dramatically improve restaurant food safety practices
- Continuous collection and analysis of food temperature data reduces food safety risks and product loss
- Continuous data collection also pushes up the quality of food delivered
- Automated data collection yields labor cost savings and more accurate data
- Critical control points can now move upstream to equipment performance, a leading indicator of temperature problems
- Equipment performance links food safety and asset management, which can drive down operating costs

## Introduction: Food Safety and "HACCP"

Safe Zone

135°  Minimum for hot food

Danger Zone

41°  Maximum for cold food

Safe Zone
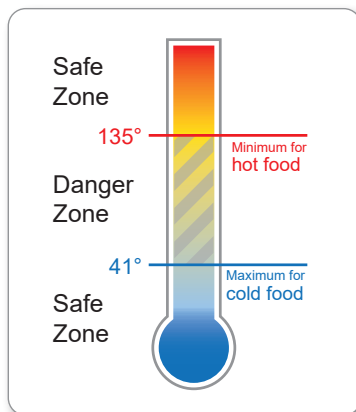
Restaurants, convenience stores, and other businesses involved in the sale of food all have programs in place to prevent conditions that can cause their products to become unsafe due to contamination. Most companies employ practices consistent with a systematic process known as HACCP, or Hazard Analysis and Critical Control Points.

HACCP, as its name suggests, aims to address areas in the production of food most at risk for introducing hazards ("critical control points"). In restaurants and convenience stores, refrigeration equipment and food cooking or warming equipment are two such critical control points.

To manage these control points, food service operators are required to record temperatures at regular intervals to ensure that food temperatures stay within the "safe zone". Most commonly, these data points are collected and recorded manually on logs that are kept on site for the local Food Inspector to review when they show up for their periodic inspections. In some cases, the logs are also filed in company archives, should the need ever arise to review historical data.

In practice, there are many limitations to standard food safety management procedures. These limitations include:

- Minimal data sampling – usually just 2-4 data points per day are taken for any given critical control point.

- Inaccurate data – restaurant operations require constant management attention, and it is not uncommon for opening or closing managers to "fall behind" such that the data collection is rushed or may not happen at all.

- Inaccessible records – it is quite possible that the handwritten data logs will be illegible, difficult to find quickly, or lost entirely.

The rise of the minimum wage is going to put further pressure on managers who are asked to do more in less time, and this is only going to make food safety data collection more challenging.

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## Transformational Change

New technology – the so-called "Internet of Things", or "IoT" – is poised to dramatically improve restaurant food safety practices. It is now cost effective to continuously monitor key food safety parameters like refrigeration temperatures and hot food hold times. Doing so leads to significant benefits that include reduced labor costs, improved product quality and reduced food safety risk. This new technology also creates a valuable linkage between food safety systems and asset and energy management systems.

An IoT-empowered food safety program has many advantages, including:

✅ **Automated data collection:** Automation reduces the burden on store managers, who in the past have been asked to step away from the pressing demands of running a restaurant or convenience store to take data samples on a regular basis. Automation of data collection also helps to eliminate any clerical errors which yield inaccuracies in recorded data points. The result is labor savings and truly consistent, accurate data collection that can be much more effectively used to ensure product quality and safety. Store managers can often spend an hour or more each day taking and recording temperature samples.

Overall food safety efforts can take a considerable amount of time. For Quick Service Restaurants, it may take hours of manager time each day. Saving 1 hour each day can yield significant savings across a chain (and this number is only getting larger based on the dramatic changes in minimum wage that are in process). This is valuable time that could be spent attending to the needs of customers or addressing other critical issues involved in day-to-day store operations.

✅ **Continuous monitoring:** Today most food service businesses spot check food temperatures a few times a day – often in the morning and in the second half of the day. If equipment fails and temperature drifts out of the safe zone, measuring twice a day means a problem would be caught in a minimum of 12 hours. This lag is a major risk. And there is also the possibility that between spot checks, the temperature is out of the safety zone for many hours but returns to the safe zone by the time of the next measurement. In that way, the food safety risk – which may happen on a very regular basis due to operational practices or habits – is never detected. All of these risks are eliminated with technology that measures the temperature continuously (typically every minute).

✅ **Automated data analysis:** If Food Safety is measured every minute, each critical point yields 1,440 data points per day. The challenge now shifts to making effective use of all that data. Thanks to the near limitless data storage and analysis that is available from cloud-based software, it is now possible to automatically analyze this mountain of data to immediately reveal hidden problems and reduce risk. Recurring events may be leading to hazards – events such as deliveries, inventory, new employee trainings, extended prep periods, and busy days. Advanced data analysis can uncover and quantify the level of risk associated with each of these potential hazards.

✅ **Remote, real-time accessibility:** Of course, simply becoming aware of unsafe food conditions is not the primary goal- the goal is taking corrective action in a timely way to reduce possible exposure to this risk and avoiding costly product loss. Remote access to real-time data empowers an organization to take the right actions quickly. Access to this data can now be simultaneous for the location manager, the area manager, and the regional manager or corporate food safety personnel. Just as POS data is now "streamed" to the entire organization in real-time, critical operational data can also be streamed.

✅ **Digital record keeping:** Last, but not least, capturing Food Safety temperatures electronically enables digital record keeping. Rather than sifting through piles of paper-based temperature logs that are taking up valuable space in a crowded restaurant office, if a temperature collection system is connected to the internet, its data can be stored in the cloud, facilitating the process of retrieving and analyzing it at a later date, should the need arise to review it.
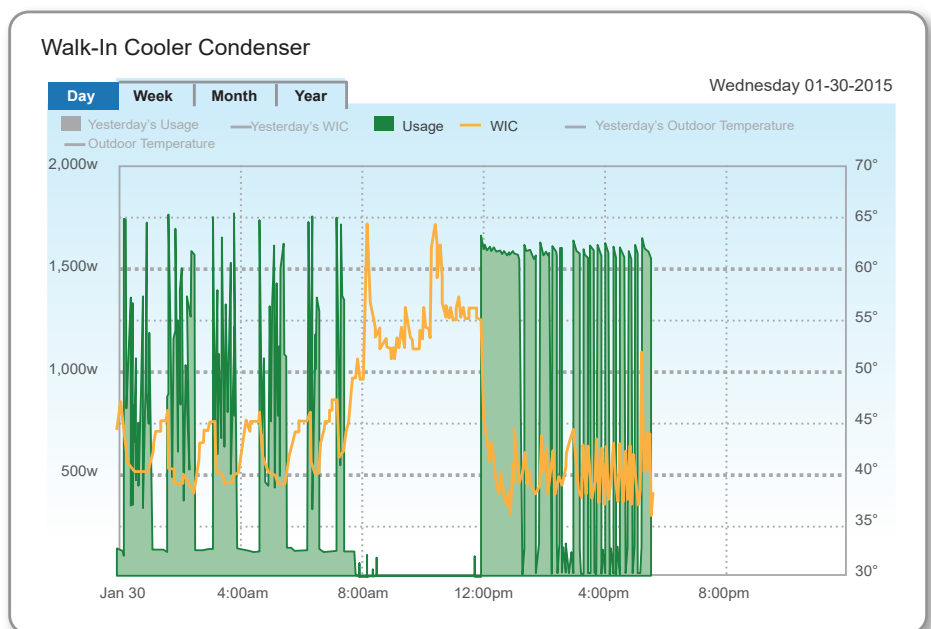
## More Transformation: Improved Product Quality

For years if not decades, some industries have been monitoring the temperatures of their product on a minute-by-minute basis – food processors, hospitals, health clinics, and laboratories – because the cost to do so was justified. The cost of this capability is now low enough that it is justifiable to do the same for the food service industry. In most ways, food quality is the other end of the spectrum from keeping food safe: making food delicious. Now more than ever freshness, texture, appearance, and all aspects of product and food quality are critical. Consumer demand for these attributes is at an all-time high. A few examples of common sources of food quality degradation include:

- ✅ Walk-in freezers with excessive electric defrost temperature spikes can cause melting and re-freezing daily, which can degrade meat products

- ✅ According to Food Safety Magazine, chronically warm freezers can also degrade breaded chicken: "Frozen breaded chicken held at too high a temperature suffers too, when moisture from the meat gets into the breading, which causes it to brown unevenly or flake off, while reducing the useable life of the fryer oil."[1]

- ✅ For a walk-in freezer nested inside a walk-in cooler, if the freezer doors do not shut properly, the cooler will likely become too cold, negatively affecting produce like lettuce, tomatoes, etc.

- ✅ In walk-in freezers with frozen desserts, like ice cream, temperature variations can begin a melting process that changes the texture of the food, creating more crystals and significantly affecting taste

- ✅ Food warmers that are too hot dry out product, which leads to less satisfying meals and, in some cases, excessive shrinkage due to moisture loss

## Addressing Root Causes: Employees & Vendors

There are many human factors that work against food safety and product quality. Both employee behavior and vendor behavior must be managed properly within a HACCP program. For example, it is very common for employees to turn off some or all of a walk-in cooler or freezer to do weekly or daily inventory or stocking. Not only is this practice a violation of most company policies, the real danger is when the employee forgets to turn the equipment back on. This type of pattern can now be monitored via temperature and energy usage data (more on this in the next section). This chart shows the large gap spanning noon to 5am during which the breaker for a walk-in freezer at a restaurant was turned off. Although the temperature inside this freezer was not being measured directly, the outdoor temperature was over 80 degrees and the inside of this freezer was surely well above the safe temperature for 10 hours or more.



1 http://www.foodsafetymagazine.com/magazine-archive1/augustseptember-2009/foodservice-distribution-maintaining-the-cold-chain/

The other common human factor is vendors making deliveries to walk-in coolers or freezers. 90% of walk-ins have a sign that says "do not prop the door open" and yet it is all too common for vendors to do so anyway. The same risks are present here – propping the door open is bad in general and it is very bad when the vendor forgets to close the door when they leave. As illustrated in this chart, propped doors mean excessive refrigeration compressor run times and higher-than-safe temperatures – both conditions that can be detected with an IoT solution. The green area is energy usage – you can see the compressor is running all night long. The yellow is the temperature – you can see it is above 55 degrees until the staff closes the walk-in cooler door just before 9 am.



**Staff closes walk-in cooler door**
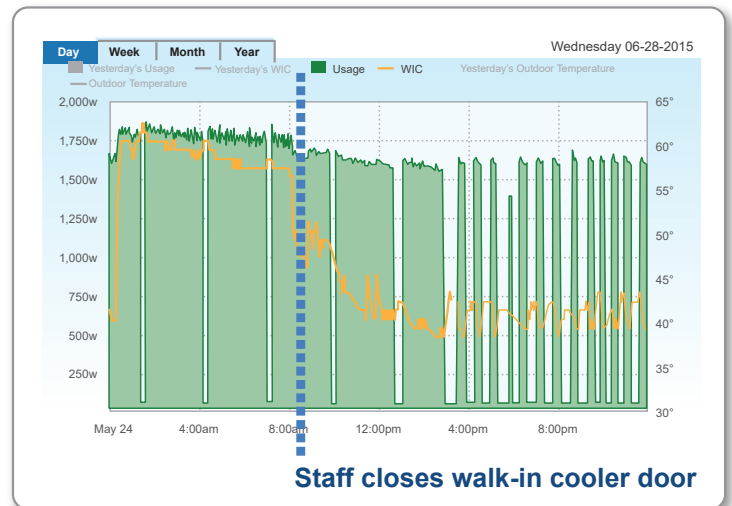
This incident was reported to the vendor, who responded with:

*Good Morning,*

*If I understand this accurately, it appears our Driver left the walk-in cooler door open after he completed the Delivery?*

*If so, please accept my sincere apology and rest assured I will address this immediately with the Driver's Supervisor!*

## Addressing Root Causes: Equipment Performance

Automated refrigeration equipment performance analytics are now possible with energy management system technology. Thanks to advances in various IoT technologies, it is now cost effective to capture the data needed for these analytics. The most common data types analyzed include minute-by-minute equipment-level power consumption, temperatures, and in some cases other parameters like pressures.

The ability to use this data and analysis to understand equipment performance is a game-changer for HACCP compliance. **Next to employee error, the number one source of temperature related food safety risk is equipment under-performance or failure.** Because of this, equipment performance monitoring is an emerging food safety risk-mitigation strategy. And, in addition to improving food safety, equipment performance monitoring can identify equipment problems before they become emergencies, which are expensive to resolve and highly disruptive to customers and employees. Repair and maintenance costs, while not obviously connected to HACCP compliance, are indeed linked. Industry survey data from the Professional Retail Store Maintenance Association (PRSM) uncovered the "premium" that emergency service carries: more than double. Said another way, service calls that are scheduled during normal business hours cost less than half as much as the same service performed as a result of emergency or after-hours service calls.
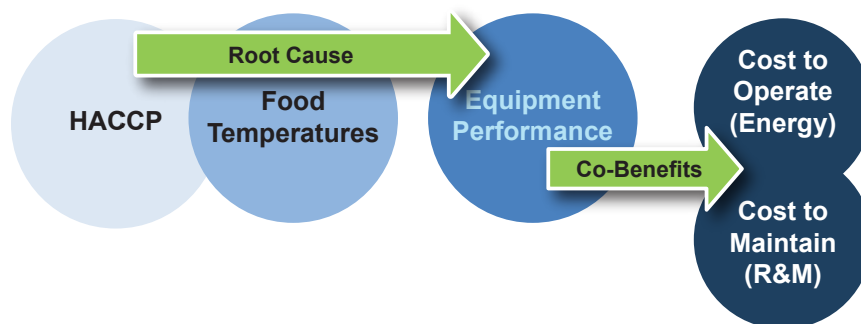
As the most forward thinking operators are finding, there is also an important linkage between energy efficiency and food safety. The proverbial 3-legged stool for refrigeration equipment includes energy efficiency. In an article from Foodservice Equipment & Supplies Magazine, the Editors make a point of linking equipment performance with both food safety and energy efficiency, stating that, "maintaining [equipment] is not only important from a food safety standpoint, but also helps ensure optimum energy efficiency."[2]

The goal is to have equipment that consistently delivers the required temperature profile for food safety using as little energy as possible. Struggling equipment works harder to deliver the required temperature until it ultimately can't anymore.

In addition, equipment performance monitoring saves labor. Just as HACCP automation saves time, equipment performance monitoring saves time, too. For store managers, the failure of critical equipment inevitably means they need to stop doing what they are doing and divert their attention to the issue. Time spent may include removing product from the failed equipment and finding room for it elsewhere; crisis management, if product must be thrown out, leaving holes in the inventory required to meet customer's needs; and time spent attempting to describe the problem to a refrigeration technician while managing the repair process.

## Convergence: Food Safety and Asset Management

The prior sections of this paper have examined the impact of new technology on the accuracy and scope of food safety and product quality business processes. As food safety expands to include equipment performance, there is an increasing convergence between these new and improved food safety monitoring systems and other business processes and technologies – namely energy management systems and asset management systems. This convergence is where the Internet of Things begins to be the Internet of "Everything", where nearly every device and type of data can be accessed remotely via the internet.

With the Internet of Everything coming, companies that are considering systems for capturing HACCP data may also be considering widespread deployment of internet-connected energy or asset management systems. Frequently, these projects are managed and driven by different parts of an organization, which can lead to implementation of "siloed" systems. However, there is a valuable synergy to be gained by combining these types of systems, with benefits that neither system in isolation could deliver.

For example, most internet-connected temperature-tracking platforms begin and end with their temperature-related solution. While this can be very valuable in and of itself, it represents yet one more online account operators need to manage, with unique URLs, login IDs, and passwords.

With the broader set of capabilities offered by systems that integrate food safety with energy and asset management, there are a number of factors to consider when weighing them against systems that deliver only food safety data:

- Single platform for integrating data
- Flexibility for deploying both wired and wireless sensors – refrigerated prep tables can often be on casters and are moved for cleaning, making wired temp sensors difficult to manage
- Mobile & Cloud-based access to data and alerts
- Enterprise-wide reporting infrastructure
- Exceptions-based reporting

2 http://www.fesmag.com/products/product-knowledge-guide/preparation-equipment/5922-maintaining-a-refrigerated-prep-table

## Summary

Thanks to new technology, the traditional approach most food service businesses have taken to address food safety and HACCP compliance can now be dramatically improved. Many critical control points can now be automatically monitored every minute of every day, which slashes potential hazards and boosts product quality; this in turn is increasingly crucial to brand positioning and revenue growth. Food safety can now reach "into the future" by monitoring equipment performance, predicting possible deviations from the safe zone for refrigeration and warming equipment. Monitoring equipment performance has important side benefits of reduced repair and maintenance costs, reduced staff time spent on equipment problems, and reduced utility costs.

There is a now a convergence between what used to be separate business processes and technologies such that tools and systems used for food safety and product quality assurance are now merging with those used for asset management and energy management. As the Internet of Things continues to mature, the benefits available to food service operators will continue to rapidly expand.

| Traditional | Improved |
|---|---|
| 2-3 Spot Checks per Day | Data gathering every minute |
| Pen/Paper | Digital |
| Labor Intensive | Automated |
| Reactive | Proactive |
| Avoid Illness | Maximize Freshness |
| Measure Only Temp | Measure Equipment Performance |
| Managed Stand-Alone | Linked to Asset Management |

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