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**Parallel session 5: Assessing and managing risk - HACCP and risk assessment**

**PS5.01 HACCP**

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**Abstract**—HACCP is a food safety management system that has been successfully applied across the food industry for many years. The paper reviewed the effectiveness of HACCP in controlling food safety risks in the meat industry, the integration of HACCP system in food companies, how HACCP becomes operational, the influence of HACCP on the company economy, and how employees can implement HACCP. HACCP is very effective in controlling food safety hazards if applied properly. Human and financial costs of a lack of control were examined. Management commitment underpins all aspects of the integration of HACCP within companies, and is vital for making HACCP operational. The cost benefits of HACCP were reviewed; results showed that the application of HACCP could give operational savings of \$160,000/year, and safety gains from a reduction of positive *Listeria* samples from 14%, down to 0% within three years, in two contrasting companies.

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**Index Terms**—Food Safety Management, HACCP, Hazards, Meat

**I. INTRODUCTION**

THE original concept of Hazard Analysis and Critical Control Point (HACCP) came into being when NASA asked Pillsbury to design an effective food safety control system for their astronaut programme in the early 1960s. Pillsbury worked with NASA and the US Army laboratories at Natick [1, 10, 12]. The food industry quickly saw the potential and took up what became HACCP, into various food sectors.

In most parts of the world, the HACCP systems used today are based on a version standardized by the Codex Alimentarius Commission (Codex) in the late 60s; the latest revision was published in 2003 [3]. Many guides to HACCP are available, based on Codex HACCP [16,

12, 17]. Many countries have their own regulations regarding HACCP, for example, in the US, there are mandatory juice, seafood, meat and poultry HACCP programmes, with voluntary approaches in other sectors. In the EU, Regulations 852/2004 and 853/2004 [4, 5] were introduced to modernise and simplify an existing complex set of Directives and Regulations introduced previously. These regulations inform food business operators (FBOs) of their responsibilities for safe food production.

Regulation 852/2004 focuses on general provisions for all FBOs, whereas 853/2004 is focused on those working with animal products. The food safety procedures should be based upon HACCP, with flexibility in approach for smaller FBOs, so that procedures can be based upon HACCP, but not necessarily a HACCP system, if this is not appropriate.

This paper will focus on answering the following questions concerning HACCP, relevant to the meat industry:

1. How effective is HACCP in controlling various food safety risks?
2. How does HACCP become an integrated system in food companies?
3. How does HACCP become operational?
4. What influence does HACCP have on the company economy?
5. How can employees implement HACCP?

**II. RESULTS AND DISCUSSION**

**A. HACCP and food safety control**

The first question to answer is ‘How effective is HACCP in controlling various food safety hazards?’ This section will describe selected food safety issues and examine some cases where problems have occurred when HACCP is not applied properly.

The main microbiological issues include *Salmonella* spp, *Campylobacter*, *Escherichia coli*, particularly *E. coli* O157, *Listeria monocytogenes*, *Clostridium perfringens*, *C. botulinum*, parasites such as *Cryptosporidium parvum* and *Trichinella spiralis*. A larger number of microorganisms are also implicated in

meat spoilage, for example, *Bacillus* spp., *Clostridium* spp., *Pseudomonas* spp., *Flavobacterium* spp., *Alcaligenes* spp., and lactic acid bacteria, which although not pathogenic, may still be controlled within HACCP if criteria for their control fall within safety parameters for pathogens.

Physical hazards within meat include raw material hazards such as bones, connective tissue, horn and skin, and metal, plastic glass and other items in the processing system.

Chemical hazards in the raw materials include veterinary compounds and environmental contaminants, and in the process, cleaning chemicals, lubricants etc.

How is HACCP used to control these food safety hazards? For the microbial hazards, procedures need to be in place to minimise the risk of contamination by microbial pathogens, for example, animal welfare and hygiene, transportation, and handling up to the abattoir. Temperature control, including environmental control, and cooking and cooling profiles for processed products are also required.

For the other hazards, procedures to minimise contamination, either by good farming practices (chemical hazards), or in process hazards – physical and some chemical, are required.

The fact that there are relatively few issues with the meat industry indicates that generally processing is kept under control. When procedures are not in place, or not followed, however, then the consequences can be disastrous, for example: poor hazard identification, incorrect identification of critical control points (CCPs), inadequate critical limits, monitoring procedures or corrective actions. Finally, poor implementation and maintenance of the completed HACCP plan are serious failings in an otherwise effective system. HACCP often fails at the application of Pre-Requisite Programmes (PRPs): poor hygiene and/or cleaning; pest problems; building design or fabric maintenance issues; and poor equipment maintenance, leading to microbial build-up on food contact surfaces. Some of the following incidents will illustrate these points.

Undercooking of hamburgers by the Jack in the Box restaurant chain in the US led to over 600 cases of food poisoning, with 500 confirmed to be from *E. coli* O157. There were 200 hospitalisations and four deaths, all children. The costs to the company were \$160 million in lost sales, and lawsuits for more than \$50 million were filed [18].

Poor hygienic practices lead to cross contamination of cooked meat by *E. coli* O157 from uncooked meat in the cases of Mr Barr in Scotland in 1996 and Mr Tudor in Wales in 2005. In Scotland, 21 people died. In the Welsh outbreak, there were 157 cases, with 118 confirmed as *E. coli* O157. There were 31

hospitalisations, and one child died [13,14]. The latter case was particularly serious given that the recommendations from the Scottish case were ignored.

Cooling a can with river water contaminated with *Salmonella typhi* probably caused the typhoid outbreak in Aberdeen from corned beef in 1964. A pinhole in the can was the probable entry point. Subsequent slicing of the contents of the contaminated can spread it to equipment, surfaces and food items, causing infection of many more people than should have been the case. Over 500 people were hospitalised, with three deaths [15].

#### *B. How does HACCP become integrated within companies?*

HACCP is a food safety management system that uses quality management techniques to control food safety, for example, document control, corrective actions, specification, procedures, a food safety policy, statistical control, inspection and testing. If companies already have ISO 9001-2000, then integration of HACCP within company systems is easier. Systems such as ISO 22000 and the BRC Global Standard for Food Safety successfully integrate safety and quality. Within the EU, member states are encouraged to produce local guides to good practice to enable effective uptake of HACCP. Within the UK the Meat Plant HACCP Manual [6] is available to help. This is a simple guidance manual for meat plants initially designed to help achieve the objectives of a risk-based regime in licensed meat plants. In addition, The Guide to Food Hygiene for the Meat Industry [7] is a much more detailed document that is also recommended. It covers operator obligations, pre-requisites, HACCP, and advice on how to meet the legal compliance. It gives detail on compliance for hygiene and all other pre-requisites.

Before starting the design of the HACCP system, companies should carry out a gap analysis, including training requirements at all levels. Management commitment is vital to ensure that the results of the gap analysis are acted upon. Management should help encourage the development of a food safety culture, so that all sectors of the company are involved in HACCP, and resources are available for implementation of HACCP. The gap analysis may identify barriers to HACCP that need to be overcome before HACCP can be implemented effectively. For example management commitment, inadequate resources, poor factory layout or design, building fabric issues, distribution or marketing constraints.

The next stage in HACCP development is the appointment of a small HACCP team, made from production/operations, technical/quality, microbiology and engineering personnel, with others from, for example, purchasing and hygiene, brought in as

necessary.

Once the team is in place, the design of the HACCP system should be discussed. There have been great changes in HACCP over the past 10-20 years, with most companies now operating process-led HACCP, whereas formerly HACCP systems were product-led, and therefore more unwieldy, with many HACCP plans in operation. If relatively few different processes are used, then a generic HACCP plan could be used, or if the company has a complex set of processes, then a modular system could work. Care must be taken to ensure that multi-site organisations review the HACCP plans for each site, if a more generic approach is used.

A management plan detailing planning and development stages, and how the HACCP system will become operational, is also required.

The HACCP team will require training, preferably with Level 2 (Foundation) minimum for the team members and Level 3 (Intermediate) for the team leader(s).

The HACCP team then needs to apply the HACCP principles to the products and processes that are manufactured by the company. Operating procedures are put in place that cover all aspects of the manufacturing process.

The completed HACCP plan is then validated, before 'going live' and manufacturing product. Validation means proving that the HACCP system works; that the hazards identified are correct, that the controls are appropriate, either by pre-requisites or CCPs; that the critical limits set by the HACCP team are sensible; that monitoring is carried out often enough and by the right people to ensure that critical limits are under control. Validation means challenging the controls in place in the system, and the failure modes at each control, to think outside the box; 'what would happen if this occurred?' This is to ensure that controls work under all circumstances; at start up, close down, after cleaning, during the day shift and the night shift.

#### *C. How does HACCP become operational?*

The operational aspects of HACCP start when manufacturing product for sale occurs. This means management making sure that sufficient resources are available for CCP monitoring at the frequency within the HACCP plan, and that records are kept.

Records can be paper or electronic; whichever is used, they must be controlled, and kept for the designated period of time. Records include the basic HACCP documents, and the ongoing process and monitoring records, including CCP, calibration, traceability, recall, training, meeting and audit records.

Monitoring systems are set up, which could include Statistical Process Control (SPC). Procedures for reporting deviations should be challenged, so that staff

understand the importance of following the corrective action plan. Another aspect is the need for feedback to operational staff, by means of departmental meetings, electronic and paper notice boards, and individual feedback where relevant; for example, if quick action by a staff member has saved product rejection.

An implementation plan is required, perhaps using GANTT or PERT techniques to administer it. Implementation can be carried out all at once, or in phases; depending upon the size of the company and whether a Quality Management System (QMS) is in place.

Preliminary basic training by the HACCP team for all staff should take place in the seven principles of HACCP, its purpose and function, and the role of all staff. Line staff will need training in how the HACCP system operates, so that they can take over the running of the HACCP system. CCP monitors and supervisory staff will require more detailed training relevant to their roles.

Once the HACCP plan is operational, the system must be maintained, and verification that the system as set up is still being applied should take place. This is when the real problems can arise; does the HACCP plan gather dust on a shelf, or is it 'live' and working, and being updated, where necessary?

Verification includes auditing, compositional, chemical and microbiological testing. The SPC procedures set up above are used at this stage, and reviewed during HACCP team meetings, when deviations are also reviewed.

Regular internal auditing of procedures, records, PRPs and hygiene are carried out. Annual external third party auditing is also undertaken if the company operates the BRC or another quality and safety management system. The key point is that all audits, internal and external, are independent; not carried out by staff who wrote that aspect of the system.

#### *D. What influence does HACCP have on the company economy?*

There are costs associated with HACCP plan implementation; staff training, CCP and PRP monitoring, corrective actions, auditing, HACCP team meetings, HACCP review. For example, Killen [9] noted that a HACCP study could take between 40 days (6.5 days per person with a six-person team) to 160 days (more complex study, same size team)

Costs include time, product loss, and equipment and facilities. In contrast, if the company does not have an effective HACCP, there are also costs associated with getting it wrong; costs of recalls, a potential greater loss of product, possibly more recalls, ultimately loss of public confidence, loss of market share, and legal consequences, as noted in section II A.

McAloon [11] noted efficiency savings in the Cargill turkey business of \$150,000 per year, due to studying the cooling process for a CCP, and reducing losses at that point. In their oilseeds business, the hazard study indicated that an improvement to the location and size of a critical filter lead to an improvement in the filtration process that resulted in savings of \$60,000 per year, and improved customer relations.

In India, HACCP implementation lead to a 46% increase in output of an ice cream factory, a reduced frequency of shutdowns for cleaning and sanitation, and 10% reduction in the costs of poor quality product within 6 months of implementation. Additional benefits included a decrease in positive *Listeria* counts from 14% of samples to 1% in year one, declining to zero by year three [9].

#### *E. How can employees implement HACCP?*

Employees initially become involved with HACCP by taking part in HACCP training. If they are appointed CCP monitors, then a further level of training and involvement is required, as detailed above. Training and commitment is also required in the basic aspects of the job role, since staff need to be experienced in their jobs to be effective participants in HACCP.

An audit team needs to be set up; experienced line staff are excellent choices for internal auditors, since they know what the particular jobs entail. Auditors should be independent of the team that wrote that part of the HACCP plan, and need training in audit skills and techniques. Maintaining independence of the HACCP plan can be difficult, because the HACCP team often have the best knowledge of the system. Internal auditors should not audit their own departments, for the same reason. In either case they could be members of another in-house HACCP team.

Management also need to be involved with and fully understand HACCP, to ensure that resources are available for the HACCP team to be able to carry out the HACCP study and implement and maintain the system. Management therefore also need training in the principles and requirements of HACCP. All sectors of management need to be involved, not just production or operations and technical or quality; sales and purchasing as well, as HACCP impinges upon all aspects of the company culture. The appointment of a HACCP Champion is a vital first step. The HACCP Champion will be a member of senior management whose role is to liaise between the board and staff, and communicate HACCP goals to staff. HACCP goals can be incorporated into company performance goals, ensuring that HACCP is seen to be of equal importance to profitable operations. HACCP goals can be part of company incentive or bonus schemes for good

performance in safety management.

HACCP should be on the agenda of team briefings at all levels within the company to ensure that the food safety culture concept is promoted throughout the company. Promotion of food safety can also be by production and safety charts on notice boards at prominent places on the production floor; by the canteen, outside rest areas, and by publishing safety data within the company newsletter, and within any promotional newsletters that the company produces.

### III. CONCLUSION

HACCP is a food safety management technique that has evolved and improved during its existence, from its early days with NASA. This paper has reviewed some aspects of HACCP implementation and the issues associated with each stage.

Management commitment is the key factor that underpins HACCP, as without backing from the board, sufficient resources for HACCP will not be made available, and the HACCP system will gather dust and not work as an operational system.

Any barriers to HACCP that have been identified during the HACCP process from initial design through to implementation should be addressed, and communicated to staff.

HACCP is a simple, logical process that should make life easier, and has the potential to save money and enhance the company reputation if properly implemented. HACCP is only as good as the staff that run the system; adequate training of staff is vital for success.

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