Application of HACCP System in the Pork Industry in Korea* - Review -

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ABSTRACT : Occurrences of foodborne disease outbreaks are increasing in Korea. Among the outbreaks, *Salmonella, Staphylococcus aureus, Vibrio parahaemolyticus* are the most important organisms and meat and meat product the major sources of infection. Hazard Analysis Critical Control Point system is a process control system designed to identify and prevent microbial and other hazards in food production. It is considered to be the best process management system by the National Advisory Committee for Microbiological Criteria for Foods, the National Academy of Science, and the Codex Alimentarius Commission. The Korean Ministry of Health and Welfare established a legal basis for the implementation of the HACCP system in Article 32-2 (Hazard Analysis Critical Control Point) of the Food Sanitation Act in December 1995. The Ministry of Agriculture and Forestry has granted research funds for the development of this model system for application to traditional food products and processed fishery products as well as to raw meats. Implementation of the HACCP system is an important step and the Korean food industry and the Government are focused on ensuring food safety in Korea. (*Asian-Aus. J. Anim. Sci. 1999. Vol. 12, No. 2 : 253-260*)

Key Words : Foodborne Disease, HACCP, Meat and Meat Products, Food Safety

INTRODUCTION

In 1996, an outbreak in Japan of foodborne disease caused by *Escherichia coli* O157:H7 and detection of that organism in imported beef in Korea heightened the public's awareness concerning foodborne disease risks. Previously, chemical and pesticide residues were perceived as the greatest risk for humans. The *E. coli* outbreak and detection shifted the concern to microbial contaminants, particularly, *Escherichia coli* O157:H7, *Salmonella spp., Campylobacter* and *Listeria monocytogenes*. This shift in awareness and opinion resulted in policy changes concerning food safety. Action was taken to strengthen the nation's safeguards against microbial contamination of meat and poultry. Policy changes stated that food safety is a shared responsibility from the farm to the table, involving the producer, veterinarian and packer as well as food service establishments and home preparers of meals. Recognition of this shared responsibility has stimulated research on the application of prevention and control methodologies along the entire food chain. One such application is the Hazard Analysis and Critical Control Point (HACCP) system which identifies specific hazard(s) and preventive measures for their control. Previously accepted as part of the food preparation industry, HACCP is now being adopted worldwide for all stages of animal production through to slaughter.

The HACCP system as applied to meat production is considered to be a food safety management system. It can be used to assure food safety at all levels of food handling, and is an important element in the overall management of food quality and safety more commonly referred to as Good Manufacturing Practices (GMP). The HACCP concept was developed in the late 1960s as a quality assurance system to enhance food safety. The basic principles underlying the concept were not new, but the introduction of HACCP signaled a shift in emphasis from resource intensive end-product inspection and testing to preventive control of hazards at all stages of food production. HACCP was initially developed by the food industry for use by food processors to prevent or control hazards, thereby improving food safety. The application of the HACCP system has been evolving and expanding to form a basis for official food control and for establishing food safety standards for the international as well as national food trade. The system is considered to be one of the most effective and efficient ways to enhance food safety.

A great deal of national and international activity related to the utilization of HACCP based systems in food safety assurance is currently under way. HACCP is increasingly being promoted throughout the world, and in some countries food control agencies are mandating the food industry, including food importers and exporters, to use HACCP based systems to assure food safety. In an environment of economic constraints, governments are under constant pressure to limit spending and to look for more efficient and effective mechanisms to carry out their food control mandate. HACCP is seen as one such mechanism.

The purposes of this review are to (1) provide information on the statistics of foodborne disease, and (2) provide an overview of HACCP in the pork industry in Korea.

STATISTICS ON THE FOODBORNE DISEASE OUTBREAK

The reporting system in Korea is specified in the

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* This paper has been presented at Pre-Conference Symposium I entitled "Recent Advances in the Production of High Quality Pork" at the 8th World Conference on Animal Production on June 28, 1998 at Seoul National University, Seoul, Korea. The paper has been reviewed and edited by Prof. P. Bosi (Italy) and Prof. Y. I. Choi (Korea).

Food Sanitation Act; the Department of Quarantine handles matters related to the foodborne disease and publishes "Statistic on the Acute Epidemics" annually. The statistics on foodborne disease are shown in table 1.

Table 1. Annual foodborne disease outbreaks in Korea

Year	Outbreak	Cases	Deaths
1987	37	548	-
1988	31	1,011	-
1989	40	889	-
1990	32	618	10
1991	42	814	10
1992	44	814	10
1993	54	1,136	10
1994	104	1,746	12
1995	55	1,584	-
1996	78	2,676	-

(KIFH, 1996)

Generally speaking the annual occurrences of outbreaks of foodborne diseases, and of cases and deaths have increased continuously. These increases may be a consequence of increased reporting. Consumers in Korea now have a serious concern for food safety, and awareness of problems, the desirability of reporting these, and the ease with which reports can be made are now much improved. However, in comparison with developed countries, the number of reports on foodborne disease in Korea is still insufficient.

WHO (1989) reported that foodborne diseases are mainly caused by improper storage, improper cooling, inadequate cooking, contaminated facilities, poor personal hygiene of food handler, and unsafe raw materials.

In 1996, 82.8% of the total of confirmed cases (table 2) was caused by bacteria; 53.3% of the total was caused by *Salmonella* spp., 15.4% by *Staph. aureus*, and 12.3% by *V. parahaemolyticus*. These data indicate that management concerns should be focused on these three organisms.

Table 2. Foodborne disease outbreaks by specific etiologic agent and year

Etiologic agent	1994		1995		1996	
	1	2	1	2	1	2
Salmonella spp.	37	635	8	173	23	1,180
Staph. aureus	10	387	1	85	10	342
V. parahaemolyticus	13	256	1	1	10	273
Pathogenic *E. coli*	1	14	-	-	1	35
Other bacterial disease	6	122	-	-	12	382
Plant poisoning	5	32	2	45	1	3
Animal poisoning	1	3	-	-	-	-
Unknown	23	241	38	984	21	461
Confirmed total	79	1,505	17	600	57	2,215

[1] Outbreak [2] Case (KIFH, 1996)

HISTORY AND PHILOSOPHY OF HACCP

The Hazard Analysis Critical Control Point system, is a common-sense, science-based approach to food production that is based on preventing hazards. The aim is to control chemical, physical and microbiological hazards throughout the entire production process- from the farm to the table.

The basics of the HACCP were developed by the Pillsbury Company with the cooperation and participation of The National Aeronautics and Space Agency (NASA), the Natick Laboratories of the U.S. Army, and the U.S. Air Force Space Laboratory Project Group (Bauman, 1992). It was first used by the Pillsbury Company in the 1960s to produce the safest food possible for the astronauts in the space program. The HACCP system was first exposed to the public during the 1971 National Conference on Food Protection (U.S. Dept. HEW, 1972). Following this conference, Pillsbury was granted a contract by Food and Drug Administration (FDA) to conduct classes for FDA personnel on the HACCP system.

The first comprehensive document on HACCP was published by Pillsbury Company (1973) and was used for training FDA inspectors in HACCP principles. A special session was held with FDA personnel concerned with acidified and low-acid canned foods; they developed and promulgated the regulations for these foods (FDA, 1973) which established a successful HACCP system. HACCP has been used in the plants of Pillsbury Company since 1971. During the 1970s and early 1980s a number of companies requested and were given information and help in establishing their own HACCP programs. It was not until 1985 that HACCP was seriously considered for broad application in the food industry. In 1985 it was recommended by the National Academy of Science (NAS) in the publication An Evaluation of the Role of Microbiological Criteria for Foods Food Ingredients (NAS, 1985). The NAS Committee (Subcommittee on Microbiological Criteria for Foods and Food Ingredients) concluded that a preventive system (HACCP) was essential for control of microbiological hazards. They concluded that end product testing was not adequate to prevent foodborne diseases.

In 1987, the National Oceanic and Atmospheric Administration (NOAA) was charged by Congress "to design a program of certification and surveillance to improve the inspection of fish and seafood consistent with the hazard analysis critical control points system." This direction has been carried out by the National Marine Fisheries Service. They have also developed definitions of terminology used in HACCP. In the late 1980s, the federally-established National Advisory Committee on Microbiological Criteria for Foods developed seven principles of HACCP, which have been adopted worldwide by the food industry. The principles define HACCP systems by identifying where hazards can occur, establishing acceptable limits for the hazards, and routinely monitoring and controlling the process. Verification and record keeping establish that a system is working properly. The NAS Committee has further refined HACCP principles by adding detailed

Table 3. Foodborne disease outbreak by related foods and year

Etiologic agent	1994		1995		1996	
	Outbreak	case	Outbreak	case	Outbreak	case
Meat and meat products	48	547	20	660	16	NA
Fishery products	17	342	9	128	26	NA
Grain products	2	49	-	-	3	NA
Milk and milk products	2	64	-	-	-	-
Fruits and vegetables	2	2	2	119	4	NA
Mushrooms	4	21	1	11	2	NA
Confectioneries	2	23	-	-	2	NA
Other cookery foods	12	395	4	81		NA
Underground water	-	-	3	96		NA
Others	7	173	-	-	17	NA
Unknown	3	130	14	441		NA

(KIFH, 1996)

descriptions of what each of these involves.

The foundation of HACCP is science and it is the best process control system available for the food industry. HACCP relies on identifying hazards by conducting risk assessments, adopting new technologies and processes that are proven to reduce pathogens, and devoting resources to the most critical areas for food safety. It has been endorsed by worldwide scientific agencies responsible for food safety.

Improving the safety of meat products is the common goal of industry, government and consumers. Food safety is everyone's responsibility, from the farm to restaurants and consumer tables. Adopting HACCP throughout the entire food chain will ensure the highest level of safety.

PRINCIPLES OF HACCP

It is important to ensure that an adequate sanitation system (sanitation standard operating procedures-SSOP) is in place for compliance with FSIS regulation. Good Manufacturing Practice (GMP) and SOPs are important because they establish basic procedures for the production of safe food. The development of a HACCP plan and a HACCP system involves the application of five Preliminary Steps and then of Seven Principles (NACMCF, 1992).

The **Preliminary Steps** are:

1. Assemble the HACCP team.
2. Describe the food and the method of its distribution.
3. Identify the intended use and consumers of the food.
4. Develop a flow diagram which describes the process.
5. Verify the flow diagram

Assembling the HACCP Team: An important step in developing a plan is to gain management commitment and assemble a HACCP team. Top management must be fully committed to product safety through HACCP to make the program effective. After commitment is obtained, the team should be assembled. It should consist of individual(s) from all aspects of production and should include at least one individual trained in HACCP.

Product Description: The description should include the products within the process, their distribution, intended use, and potential consumers. This step will help ensure that all areas of concern are addressed.

Flow Diagram: The HACCP team should develop and verify a flow diagram for production of the product(s). A simple flow diagram which includes every step of production is necessary. The flow diagram should be verified for accuracy and completeness by physically walking through each step in the diagram on the plant floor. The purpose of the flow diagram is to provide a clear, simple description of the steps in the process which are directly under the control of the facility.

Hazard Analysis: A hazard has been defined as any biological (B), chemical (C) or physical (P) property that may cause a food to be unsafe for human consumption. The hazard analysis is one of the most critical steps in the development of a HACCP plan. The HACCP team must conduct a hazard analysis and identify steps in the process where significant hazards can occur. The significant hazards must be "of such a nature that their prevention, elimination, reduction or control to acceptable levels is essential to the production of safe food." (NACMCF, 1992). The team should focus on risk and severity as criteria for determining whether a hazard is significant or not. Risk, as defined by the National Advisory Committee is, "likelihood of occurrence." "The estimate of risk is usually based on a combination of experience, epidemiological data, and information in the technical literature" (NACMCF, 1992). Severity is the potential magnitude of the consequences to the consumer if the hazard is not adequately controlled. Hazards that are not significant or not likely to occur will not require further consideration in the HACCP plan. The hazard analysis and identification of associated preventive

measures accomplishes the following:

Identifies hazards of significance and associated preventive measures.

The analysis can be used to modify a process or product to further assure or improve food safety

The analysis provides a basis for determining CCPs (see principle 2, below)

Critical Control Point (CCP): A CCP is any point, step, or procedure at which control can be applied so that a food safety hazard can be prevented, eliminated, reduced, or controlled to acceptable levels. Information developed during the hazard analysis should enable the HACCP team to identify which steps in the process are CCPs. A decision tree, such as the NACMCF Decision Tree may be useful in determining if a particular step is a CCP for an identified hazard.

Different facilities preparing the same product can differ in the risk of hazards and the points, steps, or procedures which are considered CCPs. This can be due to differences in each facility layout, equipment, selection of ingredients, or the production process that is being used.

Critical Limit: A critical limit is a criterion that must be met for each preventive measure associated with a CCP. Therefore, there is a direct relationship between the CCP and its critical limits that serve as boundaries of safety. Critical limits may be derived form sources such as regulatory standards and guidelines, scientific literature, experimental studies, and advice from experts. Critical limits must be based on the best information available at the time to provide a safe product and yet must be realistic and attainable. Establishments must keep in mind that any product which does not meet the critical limit must have a Corrective Action taken. Corrective actions may be as simple as re-processing or re-packaging or may require destroying the product.

Monitoring: Monitoring is a planned sequence of observations or measurements to assess whether a CCP is under control and produces an accurate record for future use in verification. It serves three purposes:

1) Monitoring is essential to food safety management in that it tracks the systems operation.
2) Monitoring is used to determine when there is a loss of control and a deviation occurs at a CCP, exceeding the critical limit. Corrective action must then be taken.
3) Monitoring provides written documentation for use in verifying the HACCP plan.

Because of the potential serious consequences of a critical defect, monitoring procedures must be effective. Continuous monitoring is possible with many types of equipment, and it should be used when possible. Individuals monitoring CCPs must:

1) Be trained in the technique used to monitor each preventive measure;
2) Fully understand the purpose and importance of monitoring;
3) Have ready access to the monitoring activity;
4) Be unbiased in monitoring and reporting; and
5) Accurately report the monitoring activity.

All records associated with monitoring must be signed or initialed, dated, and the time recorded by the person conducting the monitoring activity.

Corrective Actions: Corrective actions are procedures to be followed when a deviation occurs. Because of variations in CCPs for different products and the diversity of possible deviations, specific corrective action plans must be developed for each CCP. The actions must demonstrate that the CCP has been brought under control and that the product is handled appropriately.

Record-Keeping: Record keeping is a critical aspect of the HACCP system. Records must be accurate and reflect the process, the deviations, the corrective actions, etc. Lack of accurate, current records may be cause for withholding or suspension of inspection from the plant. It is also important that all HACCP records dealing with CCPs and corrective actions taken, be reviewed on a daily basis by an individual who did not produce the records and who has completed a course in HACCP, or the responsible establishment official who must sign or initial, date and record the time all records are reviewed. The HACCP plan and associated records must be filed at the meat and/or poultry establishment.

Verification: Verification consists of the use of methods, procedures or tests in addition to those used in monitoring to determine that the HACCP system is in compliance with the HACCP plan and whether the HACCP plan needs modification. There are three processes involved.

1) The scientific or technical process to verify that critical limits at CCPs are satisfactory and review of the critical limits to verify that these are adequate to control hazards that are likely to occur.
2) Process verification to ensure that the facility's HACCP plan is functioning effectively.
3) Documented periodic reassessment, independent of quality audits or other verification procedures, that must be performed to ensure the accuracy of the HACCP plan.

Sanitation SOPs: According to USDA's Pathogen Reduction/HACCP regulation (USDA, 1996), effective establishment sanitation is essential for food safety and to successfully implement HACCP. There are direct and substantial links between inadequate sanitation and the contamination of meat and poultry products by pathogenic bacteria. Sanitation SOPs are necessary because they clearly define each establishments

responsibility to consistently follow effective sanitation procedures and substantially minimize the risk of direct product contamination and adulteration.

Microbial testing for indicator organisms can be used to validate CCP effectiveness, and to establish in-plant trend analysis. Microbial testing should be part of a sanitation program in order to validate effectiveness. Microbial testing does not indicate that the product is safe, but it is used to verify that the process was in control.

The **Seven Principles of HACCP** adopted by the National Advisory Committee on Microbiological Criteria of Foods (NACMCF, 1992) are:

1. Conduct a hazard analysis. Prepare a list of steps in the process where significant hazards occur and describe the preventive measures. There are three types of hazard:

Biological - primarily concerned with pathogenic bacteria, such as *Salmonella, Staphylococcus aureus, Campylobacter jejuni, Clostridium perfringens, Clostridium botulinum, Listeria monocytogenes, and Escherichia coli* O157:H7; also should consider *Trichinella sprialis,* and other parasites, as well as potential pathological concerns.

Chemical - toxic substances or compounds that may be unsafe for consumption; i.e., cleaners, sanitizers, pesticides, insecticides, rodenticides, paint, lubricants, etc.

Physical - foreign objects which may injure the consumer; i.e. rocks, stones, wood, metal, glass, nuts, bolts, screws, plastic, knife blades etc.

2. Identify the critical control points (CCPs) in the process. A critical control point is defined as a point, step or procedure at which control can be applied and a food safety hazard can be prevented, eliminated or reduced to an acceptable level.

3. Establish critical limits for preventive measures associated with each identified CCP. A critical limit is defined as a criterion that must be met for each preventive measure associated with a CCP. Each CCP will have one or more preventive measures that must be properly controlled to assure prevention, elimination, or reduction of hazards to acceptable levels.

Each preventive measure has associated with it critical limits that serve as boundaries of safety for each CCP.

4. Establish CCP monitoring requirements. Establish procedures for using the results of monitoring to adjust the process and maintain control.

5. Establish corrective action to be taken when monitoring indicates that there is a deviation from an established critical limit.

6. Establish effective record-keeping procedures that document the HACCP system.

7. Establish procedures for verification that the HACCP system is working correctly.

The written document that is developed from the application of these steps to the production of a food product is the HACCP Plan. The next step is to implement the plan with the result being a HACCP system. Finally, the HACCP system must be maintained through periodic verification and updating.

IMPORTANCE OF HACCP UNDER WORLD TRADE ORGANIZATION (WTO)

To address the role of Codex standards in the World Trade Organization (WTO) and what are now binding obligations on governments in that organization, it is important first to understand the two different WTO agreements under which the Codex standards are relevant. The agreement on Technical Barriers to Trade (TBT Agreement) was first negotiated in 1979 as part of the Tokyo Round of negotiations as a limited membership agreement under GATT. Currently the WTO has 112 member governments but it is expected to rise to at least 125 members, the number of governments in the GATT when the negotiation concluded.

The Technical Barriers to Trade Agreement and the Sanitary and Phytosanitary Agreement are two very distinct agreements, their references to Codex standards are different and they have different legal implications.

The Technical Barriers to Trade Agreement is defined according to the type of measure it covers and the Sanitary and Phytosanitary Agreement is defined according to the objective of a measure. The Technical Barriers to Trade Agreement covers all technical regulations (mandatory requirement), voluntary standards and conformity assessment procedures; any other kind of a measure is not covered by the TBT Agreement. On the other hand, the Sanitary and Phytosanitary Agreement covers any kind of measure whose purpose is to protect human health from food-borne risks and diseases carried by animals; to protect animal health from risks in feedstuffs and from animal diseases, and to protect plant health. Under the Sanitary and Phytosanitary Agreement it makes no difference what kind of measure is used, only its purpose. The distinction between these two agreements is important when considering the Codex standards because they impose very different legal obligations. The SPS Agreement recognizes the right of governments to restrict trade in order to protect health and it has as an objective the improvement of health conditions. However, the SPS Agreement is an umbrella agreement. It does not go into the details of how governments must go

about taking SPS measures, but provide the basic rules against which the measures will be judged in case of a trade dispute. As an umbrella agreement, it also allows for bilateral agreements in this area (Stanton, 1996).

The SPS agreement recognizes the right of a government to restrict trade when it is necessary to protect health, but the decision as to whether a measure is necessary to protect health must be based on scientific principles. A government cannot restrict trade or maintain a restriction against available scientific evidence.

One provision of importance for Codex is that the agreement encourages governments to use international standards, and in terms of food safety it very explicitly indicates the Codex standards. The recognized Codex standards are those relating to food additives, veterinary drug residues, pesticides, contaminants, methods of analysis and sampling, and codes and guidelines of hygienic practice. The SPS Agreement gives equal weight to standards, guidelines and recommendations.

Several paragraphs related to food safety are documented in the guidelines prepared by Codex Committee on Food Import and Export Inspection and Certification System. Risk analysis should be applied to all parts of the food chain, including agricultural inputs and pre-harvest procedures, to enable inspection resources to be targeted effectively on hazards to public health. Within the Codex system, procedures have been established for the assessment of risks arising from the presence in food of additives, chemical contaminants, pesticide residues and veterinary drug residues. Biological agents such as bacteria, viruses, parasites, etc, have not in the past been the subject of systematic risk assessment by the Codex Alimentarius Commission.

The principles of HACCP developed by the Codex Committee on Food Hygiene provide a systematic basis for the effective identification and prevention of hazards in food, including biological hazards. The use of a HACCP approach by food businesses should be recognized by governments as fundamental tool for improving the safety of foodstuffs.

The United States Department of Agriculture (USDA) published a final rule in July 1996 mandating that HACCP be implemented as the system of process control in all USDA inspected meat and poultry plants. As part of its effort to assist establishments in the preparation of plant-specific HACCP plans, the Food Safety and Inspection Service (FSIS) determined that a generic model for each process defined in the regulation will be made available for use by the industry. In May 1996, FSIS awarded Contract Number 53-3A94-6-04 to the International Meat and Poultry HACCP Alliance for the development of ten generic HACCP models.

LEGAL STATUS OF HACCP SYSTEM IN KOREA

In order to introduce the HACCP system to Korean food industry, the Ministry of Health and Welfare (MOHW) in 1992 granted research funds for the development of HACCP model systems on mainly perishable food products such as processed meat products, fishery products, and dairy products. MOHW applied a HACCP model system, based on the system developed by the research, to a selected meat processing company to discover problems which can occur in the course of application of a new system. MOHW established the legal basis for implementation of HACCP systems through revision of the Food Sanitation Act in December 1995 when Article 32-2 (Hazard Analysis Critical Control Point) of that Act was established. The objectives of this Article are to prevent food products from contamination by hazardous materials during the raw material management step, processing step, manufacturing step, and transporting step.

The Ministry of Agriculture and Forest교 (MAF) has also granted research funds for the development of HACCP model systems in traditional food products, processed fishery products as well as raw meats. Considering the situation, it can be concluded that the application of HACCP systems in Korea is just beginning.

Research projects on the HACCP funded by MOHW are as follows:

1992 - "Studies on the Good Manufacturing Practice in Korean food industry." This research project contains GMP (Good Manufacturing Practice), comparison of GMP and HACCP, and consideration of 7 principles in HACCP system.

1993 - "Studies on the Hazard Analysis of Ham and Sausage Products." This research project covers hazard analysis at each production step.

1994 - "Studies on the Critical Control Point in the manufacturing of Ham and Sausage Products." This research project covers establishment of critical control points in the manufacturing of ham and sausage products, selection of a meat processing company at which the model system will be applied, and a review of model HACCP systems developed in 1993-1994.

1995 - "Application of HACCP System in the Manufacturing of Fishery Products." This research project covers HACCP system for fishery products which will be exported to EU member countries.

1996 - "Application of HACCP System in the Manufacturing of Dairy Products."

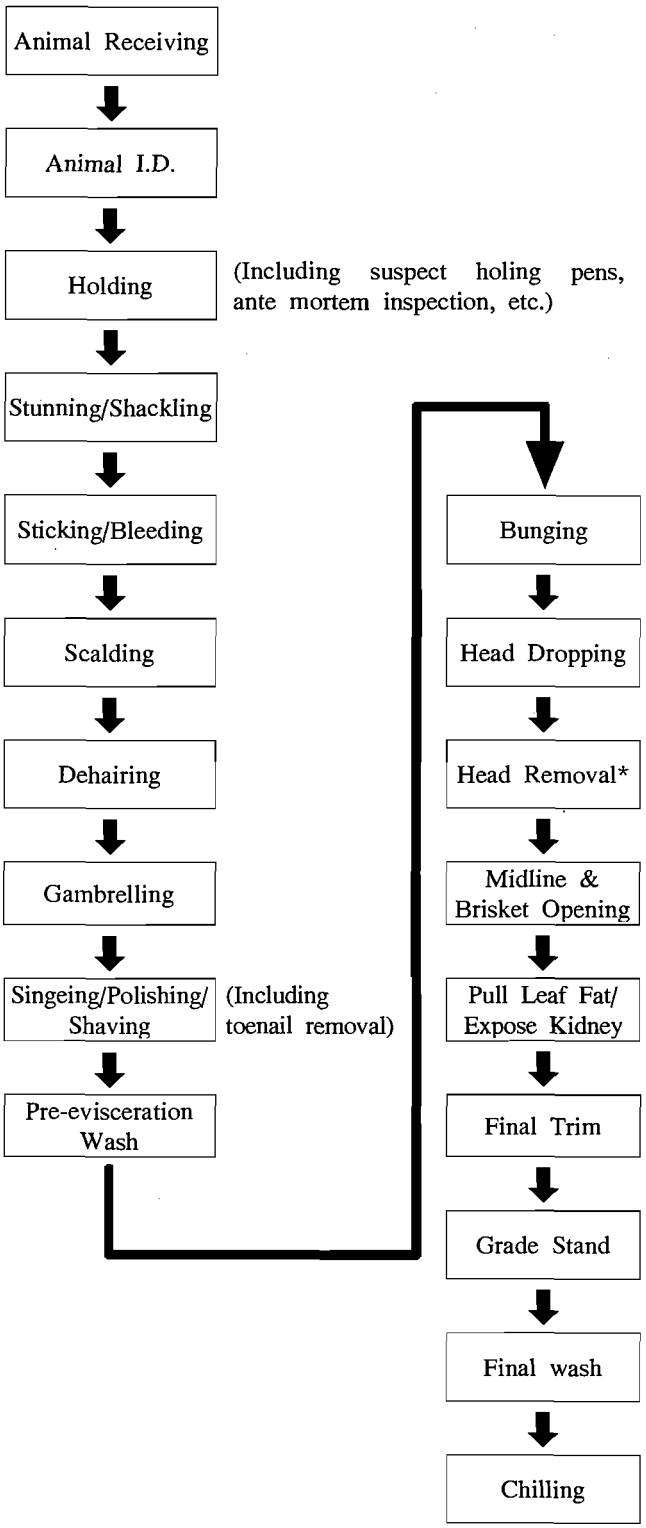
1997 - "Application of HACCP System on the Foods Catering Service Center."

Research projects on the HACCP funded by MAF are as follows:

1995-1997 - "Studies on the Safety of Raw Meat and Animal Foods during Marketing."

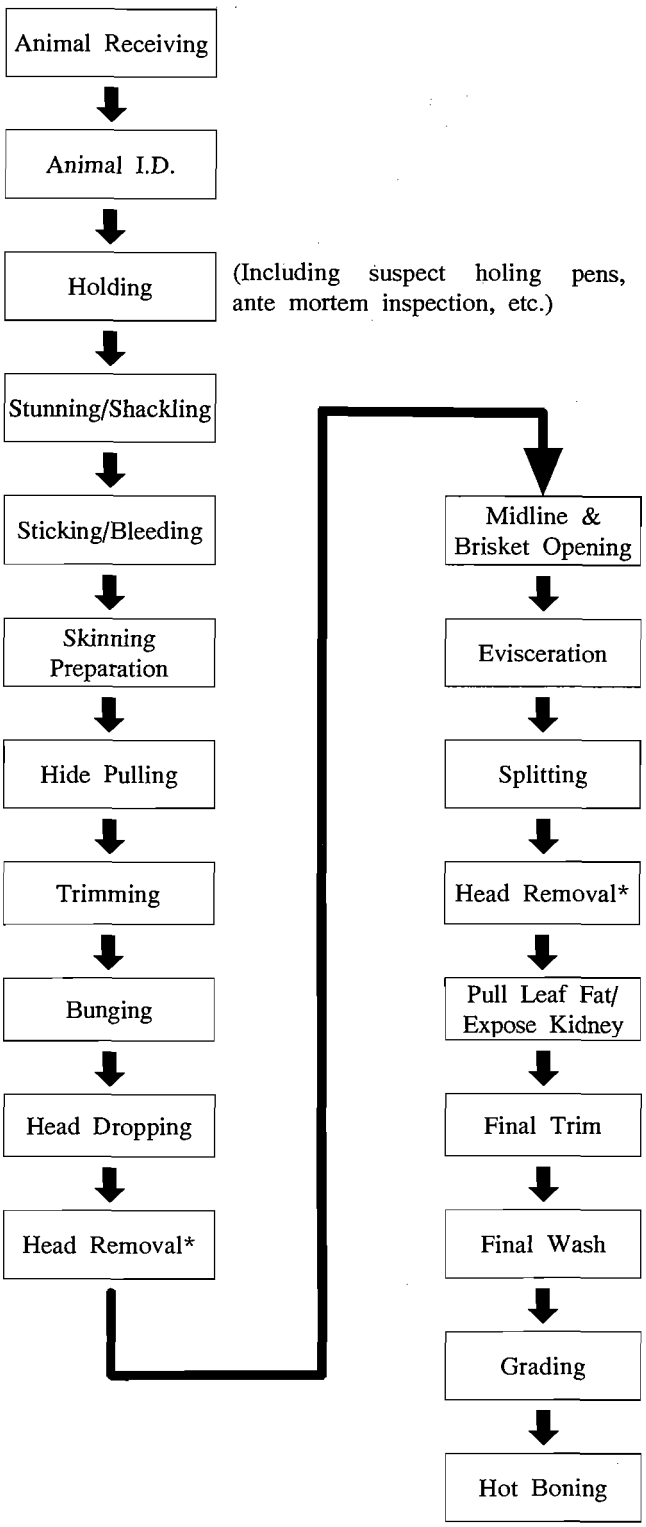
1996-1997 - Review of HACCP System Implemented in Foreign Countries and Hazard Analysis in Fishery Products.

Pork Slaughter Flow Chart (USDA, 1997)
(Skin on carcass)



* The majority of industry operations remove the head following evisceration or splitting. In these situations the head removal step should be followed by an antibacterial intervention and the step be designated as a CCP.

Pork Slaughter Flow Chart (USDA, 1997)
(Skinned Hot Boned Pork)



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