Chapter II
HACCP Plan Assessment of Virginia Meat and Poultry Processing Plants

Introduction

Assessment involves conducting audits of processing plants and reviewing ever aspect of each HACCP plan in operation. Although not exactly a part of HACCP, SSOPs are still reviewed during HACCP assessments. Along with the SSOPs, all records and a components of the HACCP plan are examined. Audits should also include a tour of the facility.

HACCP plan assessment is a key aspect involved in the HACCP program. Plans should be reviewed periodically to ensure that they are accurate and current. There is often confusion about how a HACCP plan should be developed and implemented. This confusion results in misinterpretation, and a HACCP team may use the incorrec approach when designing their plan (Rudge and Wheelock, 2000). HACCP assessmen ensures that plant personnel understand the concepts and that these plants are actually utilizing their HACCP plans so that the plan will not consist of a large file that is never used (Rudge and Wheelock, 2000). HACCP assessment also verifies that the processor is able to manufacture and distribute safe products (Ababouch, 2000).

Testing helps determine the efficacy of HACCP plans or other aspects such as sanitation and general cleanliness. Without testing, plants are uncertain if proper sanitation techniques are being followed. There should always be a legitimate purpose for testing. Mostly the purpose is to confirm that all possible modes of contamination have been iden ified and are being controlled (Kvenberg and Schwalm, 2000).

The two methods measure different units, yet as one yields increasingly higher values, so should the other. Some testing methods can be incorporated to verify the HACCP plan, but the two selected methods are more of a measure of sanitation within the plant. These two methods can be used to verify that prerequisite programs, SSOPs and GMPs, are functioning according to regulations.

A comparison of the bioluminescence method and the Standard Plate Count Method will give insight into whether both can be utilized as measures of cleanliness. Previous research has shown that there is some correlation between the methods despite the fact that the two methods measure the results differently.

The bioluminescence method measures ATP from food residues as well as microbial sources, whereas the standard plate count will measure only microbial load. Bioluminescence will generally result in higher values if the same surface is also tested using the standard plate count (Illsley et. al., 2000). For this reason, the methods were compared on a pass/fail basis in addition to the correlation that was run.

The first objective of this research is to verify that Virginia meat and poultr processing plants have a good understanding on HACCP and that the companies understand the need for HACCP. The second objective is to see if a correlation exists between the Standard Plate Count and Bioluminescence testing methods.

Materials and Methods

HACCP Assessment Development

The HACCP plan assessments were conducted at the request of Virginia State Meat Inspection. The HACCP check sheet was adopted as an instrument for assessmen of a HACCP plan. Figure 4 (in the appendix) outlines the check sheet. The sheet can be

used by the auditor to verify that certain aspects of a HACCP plan exist and indicate whether they are satisfactory. If any modifications were suggested, space was provided to record suggested modifications. Prior to use, this sheet was reviewed with state inspection and agreed upon. The HACCP assessment schedule was developed to identify when specific plants would be visited. The state was divided up into three regions with respect to meat and poultry inspection: Richmond/Ivor, Lynchburg/Wythville, and Harrisonburg/Warrenton. Plant visits were scheduled according to region. Times and dates were agreed upon by the assessment team, state inspection, and plant managemen to ensure a mutually convenient schedule.

HACCP Audits

A series of plant audits were conducted independent of state inspection. The assessment team conducting the proposed HACCP plan assessments was N.G. Marriott, M.A. Tolbert, and B.P. Quinn. A check sheet was developed to assess specifics such as SSOPs, pre-shipment review, and the components of each HACCP plan. While assessing individual HACCP plan(s), any suggestions or modifications were noted on the check sheet.

The audits included a thorough review of necessary prerequisite programs and a HACCP plan(s). Other minor details were also addressed. For instance, HACCP plans and related documents must be completed in pen, or typed. These are considered lega documents; therefore penciled information was not acceptable. Another small detail is how errors were corrected. The error must be marked through once, corrected, and then initialed. Many of these were very small details, but should be taken into account since the HACCP plan is a legal document.

Tours

Upon arrival at each plant, there was a meeting with representatives from state inspection and plant management. Plant management provided a brief tour of the facility and discussed what type of food products that they slaughter or process. This tour provided a general idea of how well the employees followed sanitation guidelines and familiarized the review team with the processing operation(s) to facilitate a more effective HACCP plan assessment.

SSOP & HACCP Documentation

Following the plant tour, all of the SSOP and HACCP related documentation was requested. The SSOPs and records were reviewed to ensure that sanitation procedures were being performed and that the plant maintained records of the procedures. Once the SSOPs were thoroughly reviewed and suggestions were noted, all HACCP plans and pre-shipment reviews were assessed.

Some plants had multiple plans, so each plan had to be reviewed separately. Starting with the HACCP team to the pre-shipment review, each area was assessed for accuracy and adherence to requirements. It was important to identify all regulatory components of the HACCP plan and ensure that they were implemented correctly.

Upon completing the review of the HACCP plan(s), suggestions were presented to the management concerning the audit. Any major deficiencies that were discovered were clearly explained to the management and it was strongly recommended that the plant take prompt action concerning any deficiency. All other suggestions were explained to the management at this time.

After leaving the plant, a brief one-page report was written. The report summarized any observations that were made about the plant or their HACCP documentation. Positive observations were cited, but the focus was clearly the negative observations. If any major problems were observed, they were noted clearly. Thi s report and the check sheet were sent to the Consumer Program Protection Manager of the Virginia Department of Agriculture and Consumer Services.

Preparing Reagents

Dilution blanks were made to perform the Standard Plate Count Method. These dilution blanks are 2% peptone solution made with Bact ® Peptone powder (Difco, 1984). When dissolved, the peptone solution was dispensed into test tubes and filled with 10mL or 9mL. The 10mL tubes were those that received the swab, whereas the 9mL blanks were used to dilute the original sample. These tubes were capped and placed into an autoclave for 15 minutes at approximately ° C. and subsequently cooled and stored in a refrigerator.

The agar was made after the tests were performed. The procedure used was similar to that described in the Approved Methods of the American Association of Cereal Chemists (AACC, 1976). First, 23.5g of the agar powder was mixed with one liter o distilled water. The mixture was stirred and heated to thoroughly dissolve the powder. The warm agar was placed into an autoclave for 15 minutes at approximately 120° C. After completion of autoclaving, the agar was cooled to approximately ° C.

Testing

The tests were conducted during the plant audit on equipment that was cleaned recently. Only equipment that was used regularly but not in operation at that time was

tested. The equipment pieces that were tested included table surfaces, grinder throats, and saw wheels. If one of these was not present or currently in use, alternate pieces were selected. Other pieces included a bowl, a cleaver, a portion stuffer, slicers, split-saws, and a wok.

For the Standard Plate Count, a sterile cotton swab was first dipped into one of the 10 mL peptone tubes. The swab was then rubbed over the piece of equipment in a 10c x 10cm square. After testing, the swab was placed into 10mL of peptone water, and broken off. This left the cotton to soak in the peptone water and created a 10^0 dilution. These microbial samples were stored in a cooler until the plant visit was completed.

Next, the same area on that location was tested with the bioluminescence method (not the exact 10cm x 10cm spot however). This swab was also sterile with the luciferan/luciferase solution attached to it. It was removed from the holder and the designated area was swabbed. After testing, the swab was plunged down into the solution and shaken vigorously for approximately 10 seconds.

Data Collection

The bioluminescence method yielded results immediately. After approximately 30 seconds, the bioluminometer gave a reading in relative light units. This number was recorded and used later in a comparison between the methods

For the Standard Plate Count, making dilutions using the 9mL peptone tubes started the process of enumerating the sample. A process similar to creating dilutions can be found in the AACC Manual (AACC, 1976).

After all of the dilutions were made, the plates were prepared. The pour plate method was incorporated for producing these plates. This method involved placing a

.1mL or a 1mL sample from one of the dilution tubes into an empty petri plate and then pouring the agar on top. A brief mixing helped spread the bacteria in the sample around the plate (AACC, 1976). After the agar solidified the plates were inverted and placed into a 35°C incubator for 48 hours.

Sveum et al. (1992), suggested that the dilutions and plating should be completed within 24 hours after the tests were taken and placed into the peptone water. However, some of the audits required an overnight stay, in which case the SPC method could not be conducted within 24 hours. Immediately upon return to Virginia Polytechnic Institute and State University, the SPC method was performed.

After the plates were in the incubator for 48 hours at 35°C, they were removed and the colonies were counted. The procedure for counting the plates and determining colony-forming units is outlined in the Compendium of Methods for the Microbiological Examination of Foods (Swanson et. al., 1992).

Data Analysis

The log values of the Standard Plate Count and the readings from the Bioluminescence were analyzed for correlation using corr procedure in SAS progra (1996). SAS provided results indicating the correlation of the SPC results with the bioluminescence data. The α-level was set at .05.

Another analysis was conducted to compare the two methods. Instead of running a correlation, agreement of the methods was determined by if both methods passed, or both methods failed. The methods were not in agreement if one passed and the other failed. A pass/fail level for the bioluminometer was determined by the procedure indicated by the manufacturers. The manufacturers provided a protocol for determining

which acceptance band to choose. Table 2 presen s the bands that can be chosen (Biotrace, 1998). The bands range from band A to band H.

For the Standard Plate Count, adequately cleaned and sanitized processing equipment should not have more then 100CFUs/cm^2 (Sveum et. al., 1992). Therefore, results for SPC above 100 are considered to be unacceptable; those less than or equal to 100 are passing. A percentage of how often the two methods agree on passing or failing was determined to see how the two methods relate.

Results and Discussion

Introduction

The need was identified for an outside evaluation of the meat and poultry plants within the state. Review of HACCP plans by internal experts or by state inspection can become very redundant. Having another individual review the plan will allow construct ve criticism and a less biased opinion.

Because these assessments had the support of state inspection, there was a state meat inspection representative present at each plant throughout the audit. Even though the audits were independent of state inspection, the investigation required a representative at each audit and state inspection seemed pleased to be indirectly included in this project. State Inspection personnel served as verification that the plant audit was legitimate. I there were any concerns about the authority of these audits, the state inspection representative would intervene and verify the authority.

State inspection also served as a medium between plant management and the auditors. In some instances the employees spoke very little or no E nglish; therefore, the state inspection representative kept notes of any suggestions that were offered, and

relayed those to the management. There was some discussion with state inspection abou certain aspects of each plan, but the auditors provided a final suggestions.

The tour provided a method to verify that the plant was following what thei HACCP plan indicated. Some plants did not need to provide a tour since their facilities were so small that the entire process was conducted in one room. A view of the operation made the assessment of the HACCP plans easier. Conducting observations from the plant and recalling them when reviewing the flow diagram aided in understanding the entire process. A diagram on paper served as a good indication of the process, but seeing it in action brings the flow diagram to life. The tour also permitted an opportunity to ask questions about any specific stage of the operation.

According to Gombas (1998) the American Meat Institute Foundation asked mea and poultr plants to complete a survey to aid in a study. Ninety-nine plants responded to the survey and were asked 31 questions concerning their plant, SSOPs and HACCP plans. The purpose of their survey was to obtain an understanding of the role tha HACCP and associated documentation are playing in the industry and how well processing plants are responding to the new regulations.

This project with the Virginia plants was somewhat similar to this cited research. However, the American Meat Institute Foundation in quired about HACCP & SSOP implementation before they were mandated in all plants, whereas the Virginia research inquired about HACCP & SSOP implementation after they were mandated.

At the time that the HACCP plan assessments were conducted, all meat and poultry processing plants were required to have HACCP plans for all products. Each o the 58 plants that were assessed had HACCP plans for every product currently being

processed. In a survey conducted in 1994 (Soderstrom and Gombas, 1995), only 23% of meat, poultry, and seafood processors (219 total responses) had HACCP plans for a products. The difference is very apparent between 1994 and 2000 when 100% of the plants had HACCP plans for each product.

Only eight of the 58 total plants that were audited were considered "small" plants. The remaining plants were" very small". Most of the deficiencies that were noted did come from the very small plants. However, because there were more "very small" plants audited, it would be difficult to compare how the deficiencies differ from the small to very small plants. Smaller plants may have fewer resources, yet larger plants have man more product lines to maintain. Therefore, it is unlikely that deficiencies could be accurately compared based on plant size.

During the assessments, many observations were made on the different aspects o each HACCP plan and they were offered as suggestions for improvements of their HACCP plans instead of being regulatory mandates. Because of the various interpretations of HACCP, the plants that were assessed had the right to accept the suggestions or disregard them. In some instances, if a major problem was identified within the HACCP plan it was strongly recommended that the plants take action.

Most of the plants appeared receptive to the evaluation of their HACCP plans. However, for some it appeared to be a slight inconvenience only because these plants were very busy at the time of the assessment. Some of the companies and employees had negative opinions of HACCP , but understood that audits were required. On three occasions, the management was not pleased to have their plans assessed. They insisted that these plans were confidential and questioned the authority of the audit.

It is understandable that angst existed with the new HACCP program and having it audited. HACCP means extra training, extra paperwork, and more time and effort than the previous practices. The management at some plants seemed concerned tha something may be found in their HACCP plan tha could result in regulatory action. I was suggested that management should realize that this audit was for their benefit and no a regulatory audit.

SSOPs

Although not an actual part of HACCP, SSOPs are a prerequisite program that is required by law. When the survey by Gombas (1998) was conducted in 1997, SSOPs had been a requirement in USD -inspected facilities for only seven months. Plants were asked when they got serious about implementing SSOPs. Sixty-eight percent of the plants claimed that they were serious about their SSOPs before the final rule was published in 1996. The remaining 32% waited until after the final rule was set before getting serious about their SSOPs.

The research conducted in Virginia was conducted more than three years after SSOPs were required; therefore, all of the plants were expected to have SSOPs currently implemented. Most of the Virginia state-inspected plants (93%) had a copy of their SSOPs on-site for review. On four occasions, plants were unable to produce the prop er documentation, and one company mentioned that it was misplaced. Each of these four plants claimed that sanitation procedures were being carried out, despite not having documentation to prove it. These plants were informed that even though sanitation practices may have been performed, documentation was necessary.

The difference between the implementation of SSOPs in 1997 and 2000 was quite apparent. Because the required SSOP implementation was a relatively new regulation, it was expected that some plants (especially smaller ones) would require more time to implement their SSOPs. That is the reason for such a high percentage of plants tha waited until after the final rule before getting serious. However, by 2000, plants had several years to prepare and implement SSOPs. If the research results revealed a low percentage of Virginia plants with SSOPs, Virginia plants should be under heav scrutiny.

The same survey by Gombas (1998) also asked whether the company had difficulty in complying with the SSOP requirements. Only two facilities reported tha compliance was difficult. The balance claimed that there were some tough areas, bu overall compliance was a minor problem. The most problematic areas were with "inspector disagreement with SSOP adequacy" and employee compliance (e.g. incomplete records, excessive deviations).

Similar to the Gombas (1998) survey, the remaining processing plants (with SSOPs on-site) in Virginia reflected little difficulty in developing and maintaining their SSOPs. Of these plants, only three did not list the procedures in a step-by-step fashion. They all had sufficient details of what procedures took place before and after processing. All plants in Virginia produced records with their SSOPs (i.e. corrective action, temperature). Unlike the survey, the majority of the records were complete, kept up-to-date and signed by the proper authority. Some SSOP deviations were reported, but they were addressed properly and did not appear to be too frequent. Only a few very minor

suggestions were made concerning the records. Only one plant had records that weren' signed and one did not note specific deficiencies, just that something was "unacceptable".

Figure 4 illustrates the deficiencies and suggestions concerning the SSOPs. The column labeled "miscellaneous" is the deficiencies that occurred in only one or two plants. From the graph, the most common deficiency was there were no SSOPs on file.

HACCP Plans

Team Members

Each plant must have a list of their team members, to conduct HACCP. Of those plants visited in Virginia, only three did not have a list of the team members (Figure 5). If one of the team members needed to be contacted it would be imperative for them to be listed. Eleven plants did contain the HACCP team list, but failed to give titles to the team members. Delegating titles to the team members allows the title to be temporarily shifted to another employee. If an employee is absent, his or her title can be placed onto another employee which can now carry out the duties accompanying that title. Also two plants did not list the company name on the front of the HACCP plan. The column labeled miscellaneous represents two very minor deficiencies: no date was given when the plan was started and the HACCP team list should be in the front of the plan.

Product description and Ingredient

There were no major suggestions for product description with the exception of one. Almost 50% of the plants indicated a maximum or minimum temperature with respect to storage (26 plants). It would be beneficial if those temperatures are listed as "less than or equal" and "greater than or equal". For example a plan may indicate, "store below 0°C". Thus, if the temperature is at 0°C, there is a deviation from the plan. By

indicating, “store at or below 0°C”, the plant will adhere to their plan if the temperature is at 0. Two of the slaughter plants failed to provide a product description for their slaughter operation. All other suggestions for product description were very minor and occurred only at one plant (Figure 6).

Each plant must have a list of ingredients for each product. Six plants did no have ingredients listed within their plan. Two indicated that there were no ingredients in their process. In this situation, the ingredients should be noted as “none”. If the ingredients apply to a slaughter plant, the animals that are slaughtered should be listed as ingredients.

The miscellaneous column for product description included 1) stating the shelf life as “up to 12 months” 2) identifying process description as SOP and 3) no produc description for all products. The one suggestion under miscellaneous pertaining to the list of ingredients was that all animals that are slaughtered should be listed (Figure 6).

Hazard Analysis

There were numerous suggestions made for the hazard analysis portion of the HACCP plans that were assessed. There appeared to be some confusion in determining where there were significant hazards in each process. Figure 7 indicates “improper identification of hazards” occurring six times. The examples of this are:

1. Slaughter hazards are half hoist and trim rail, not chilling
2. The rail (during slaughter) will address hazards except temperatur
3. Storage is more likely to cause a hazard then grinding

One plant did not identify any hazards, which suggests that a HACCP plan is no needed. However, the plant was informed about where hazards could occur in their process.

In two instances, the flow diagram did not correlate with the hazard analysis. Each step in the flow diagram should be in the same order and be identified as the sam step. This may have been just a typographical error on the part of the plant or maybe they did not fully understand how to conduct a hazard analysis. In either instance, the plant was notified about the error.

Critical Control Points & Critical Limit

The survey reported by Gombas (1998) also asked some questions about the HACCP plan. One question on the survey asked the companies to indicate the problems that they were having with respect to CCPs. Fifty-seven percent of the respondent indicated that "too many CCPs" was a source of difficulty. Only 35% indicated that "too few CCPs" was posing a problem.

In comparison, this study revealed that no plants in Vir ginia had too few CCPs from a regulatory standpoint. Each HACCP plan contained enough CCPs for the plan to meet regulatory requirements, which is one. Only one plant contained an excessive number of CCPs, where every step was a CCP. Too many CCPs can result in excessive paperwork for the employees and make it more difficult to administer the plan. It was highly recommended to this plant that they use the decision tree to reduce the number o CCPs.

Too many CCPs present a serious problem, but too few CCPs could be disastrous for a processing plant (Mortimore and Wallace, 2000). It is very difficult to decide wha is considered "too many CCPs" or "too few CCPs". Many people have different views on the definition of what constitutes a CCP. One plant may determine that it is necessar to incorporate a CCP where other plants would not include one. Several other plants in

Virginia arguably included one or two extra CCPs. In 12 cases, CCP modifications were recommended for plants, such as removing a CCP or adding an additional CCP. In these 12 cases, it was thought that removing a CCP or adding one would help the plan run more efficiently. If the plant felt comfortable with their CCPs, then those suggestions could be disregarded.

An example of a CCP mod fication would be if the auditors determined that the amount of current CCPs was not sufficient. Then, another CCP would be recommended to prevent a significant hazard from occurring. One example of where a CCP change was recommended was where one plant identified cooler storage as a CCP. Instead, it was determined that this particular plant would benefit more by transferring that CCP to a processing step. An example of when a CCP should be removed is when a plan indicates multiple cook steps, and each cook step is a CCP. The last cook step will destroy those pathogens present, which negates the need for the previous cook steps to be identified as CCPs. Using the decision tree will alleviate this problem.

At 3 plants, the CCP names were not consistent from each area of the HACCP plan. In the plan a CCP would be identified as "grind", then later it would be identified as "final grind". It is important to keep the names consistent to avoid confusion. The miscellaneous deficiency noted in Figure 8 is that if a step is not a CCP it should not be included on the CCP forms.

Very few suggestions were made regarding the critical limits for the CCPs. few modifications were suggested. Critical limit modifications include changing the temperature a which something is cooled or cooked. Another is substitution of "no contamination" as a critical limit, for "no visible contamination".

Three plants did not indicate their critical limits as a maximum or minimu value. Two of the plants used the word "average" when referring to their critical limits (Figure 9).

Monitoring & Corrective Actions

Only three suggestions were made for monitoring. These suggestions were offered to make the plan clearer and easier to understand. These were to use "sanitized" instead of the word "sterilized" and to indicate the frequency of monitoring.

Seven of the plants did not have records of any corrective actions to date (Figure 10). This observation may have resulted from some of these plants having implemented HACCP only five months prior to the assessment. These employees may be correcting the problem, but not documenting the actions that were taken. Even if a plant is following all procedures exactly, there will inevitably be a deviation at some point in time. If the management team claimed that there were no corrective actions, they were given the benefit of the doubt but the absence of corrective actions was questioned. However, if a follow-up audit is conducted the next year, and no corrective actions are documented, an investigation might be conducted on that plant. One of the miscellaneous corrective action suggestions was to list corrective actions if storage temperature was listed as a CCP.

Responsibility should also be designated for corrective actions. Two plants did not indicate which personnel would be responsible for carrying out the different aspects of the corrective actions. If the employee responsible is not listed, auditors and inspectors will not know whom to speak with regarding the corrective actions.

Verification

Another question on the Gombas survey (1998) asked the plants to rank the difficulty level of particular sections of their HACCP plans. Verification ranked as the most difficult to conduct. Only 41% of the plants in the survey had no trouble wit performing verification. The plants evaluated in Virginia did not reflect much difficulty with verification. One concern was that most plants (37 out of 58) did not indicate tha their thermometer was calibrated or did not mention how it was calibrated (Figure 11). Documentation must be provided on how a thermometer is calibrated, i.e. by inserting it into ice water equilibrated to 0°C or boiling water calibrated to 100°C. With this exception, the verification aspect for the majority of the HACCP plans appeared to be conducted properly, and the management team didn't indicate any other problems.

Record Keeping

Every plant that was audited had some record keeping system. Most of the suggestions, again, were to help clarify and make the plan easier to read. Eight plants did not indicate that no production occurred on days when HACCP data were not recorded (Figure 11). The record sheet was left blank. The plant should indicate "no production", so that in the future it is understood that there was no production that day. If the record sheet is left blank, it might lead to confusion as to why no records were documented. The 3 miscellaneous deficiencies noted in Figure 11 were to (1) indicate any revisions, (2) record a temperatures, and (3) keep records separate (i.e. raw ground and raw no - ground).

Pre-shipment Review

The pre-shipment review should be signed or initialed each time product is shipped. Also, the person who monitors the shipment should not be the one signing the documentation. This approach will permit a second individual to ensure that everything is carried out effectively.

One plant did not have any pre-shipment review documentation. The explanation was that no product had been shipped at the ime of the HACCP plan assessment. Despite this observation, documentation should be available for the first shipment. Figure 12 illustrates pre-shipment review deficiencies.

Miscellaneous

The majority of the deficiencies that were found were minor details that, for legal reasons, should be corrected. A HACCP plan is a legal document and must be treated as one. The most common mistake was how companies made corrections to the plan or records. Forty-seven of the plants, at one point or another, did not properly cross out and initial corrections. Most plants would just mark over the error and then rewrite it. The proper way is to mark once through the error, rewrite it, and initial the change. This approach will ensure that the previous error can still be read, and that an employee can be contacted as to why the change was made. If the error is completely marked out, some suspicion may be raised as to why there was a change.

Many other minor deficiencies were noted including "white out" and use of pencil. "White out" must not be used in a legal document. Changes must be made as stated previously. Also, legal documents must be in pen or typed. If the plan is written in pencil, changes can be made easily and there will be no record of the change. Other

suggestions included naming the HACCP plan, combining duplicate plans and ensuring that the plan is signed and dated. Note that Figure 13 presents miscellaneous deficiencies.

Microbial Data Collection

A total of 50 pieces of equipment were tested. Eleven of these were grinder throats, ten were saw wheels, and 18 were tables. The remaining equipment that was evaluated for microbial load is listed above.

Analysis of the data indicated an r-value of .60817. This observation suggest that there is some positive correlation between these two methods. However, the value for one of the split saws was significantly higher than all of the other values (more then three standard deviations away), so it can be rejected. Removing these values now leaves 49 total results and indicates an r-value of .4478. Using all 50 values, the results are significantly skewed towards a better correlation.

In a correlation study conducted by Illsley et. al. (2000), there was an increasing trend toward a higher CFU count with an increase in RLU. In another study by Bautista et. al. (1995), a high correlation (.85) was found between the two methods. Their correlation coefficient was much higher than that found in this study. These other experiments contradict the scattered results from this study. Illsely et. al. had tested both un-cleaned and sanitized equipment. This may have given them a broader spectrum o data, then from only testing already sanitized equipment. Most of the results from the Virginia plants were very low; some of which were 0. Those SPC values below 25 were considered estimated standard plate counts (ESPC). This will not give a good range o

values and may make the correlation coefficient lower then that of Illsely et. al., for example.

The second method used to compare these two methods was predicated on a pass/fail basis. After performing the test for the bioluminometer, band H was chosen, which meant that values less then 300 was passing (those in the caution range would be considered passing). There was a 48.9% agreement between the two methods using this test. With regards to agreement, both results passed 22 times and both results failed only 2 times. Illsley et. al. (2000) also conducted a comparison similar to this using SPC and the Biotrace Uni-Lite system. Their results indicated an 81.6% agreement, which is a sharp increase from the 48.9% discovered from this study. Although neither method had an excellent agreement, the results from this study were far below what could even be considered a close agreement.

Conclusions

It can be concluded that the HACCP plans in Virginia are working effectively if the companies are upholding them. There are some minor problems with understanding the mechanics and implementation of a HACCP plan. However, because state inspection works so closely with the processing plants, the assessed HACCP plans were designed and implemented with confidence and run effectively.

This research indicates that the SPC and RLU methods do not correlate well. Furthermore, other research results indicate that the correlation is not close to 100%. The methods measure different aspects; the SPC method measures just microorganisms, whereas the bioluminescence measures microorganisms and organic matter present. Each me hod can estimate general cleanliness and sanitation, but it is difficult to obtai an accurate comparison between the methods.

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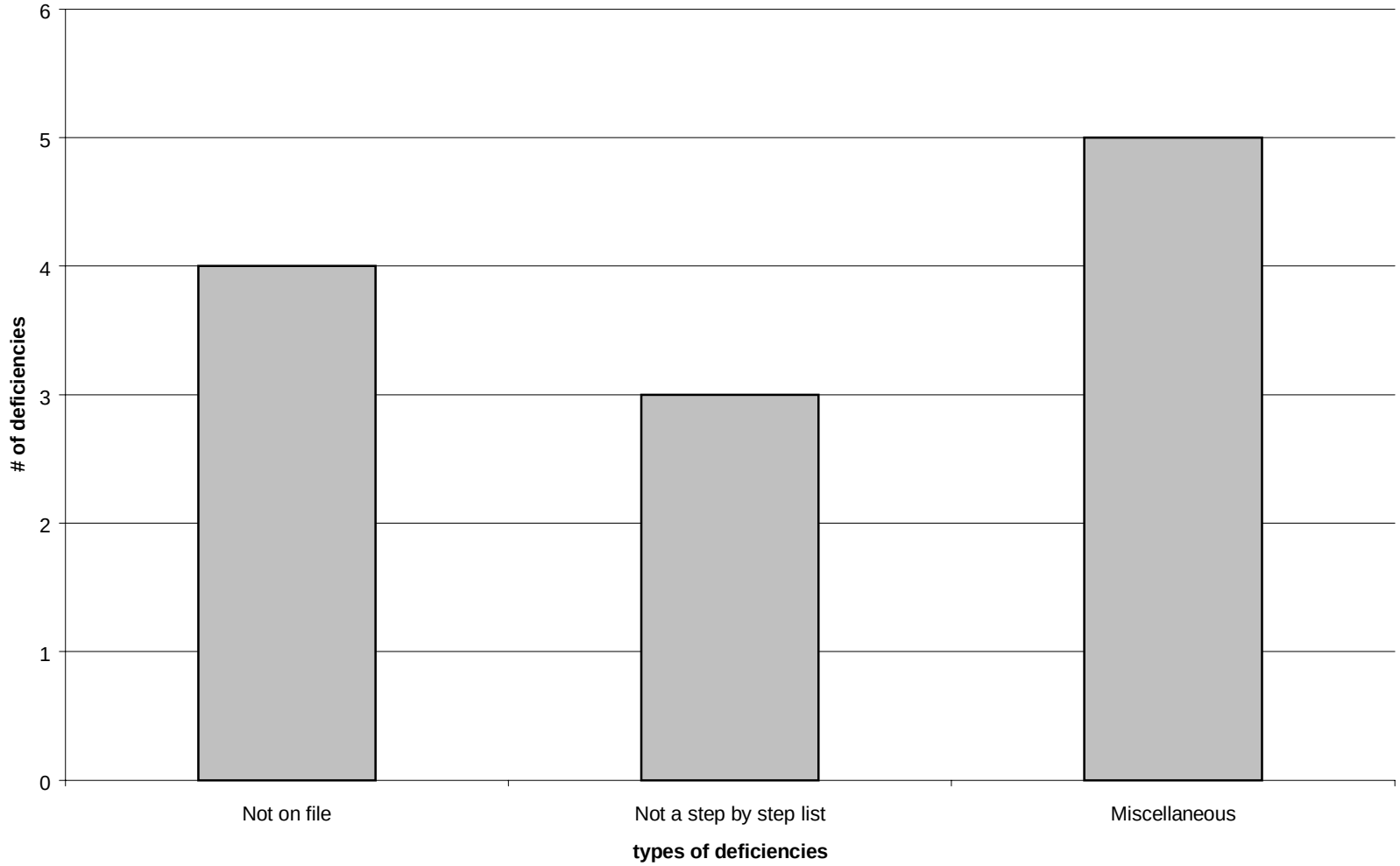

Figure 4 (SSOPs and records)
Deficiencies that were noted fro m 58 different plants assessed

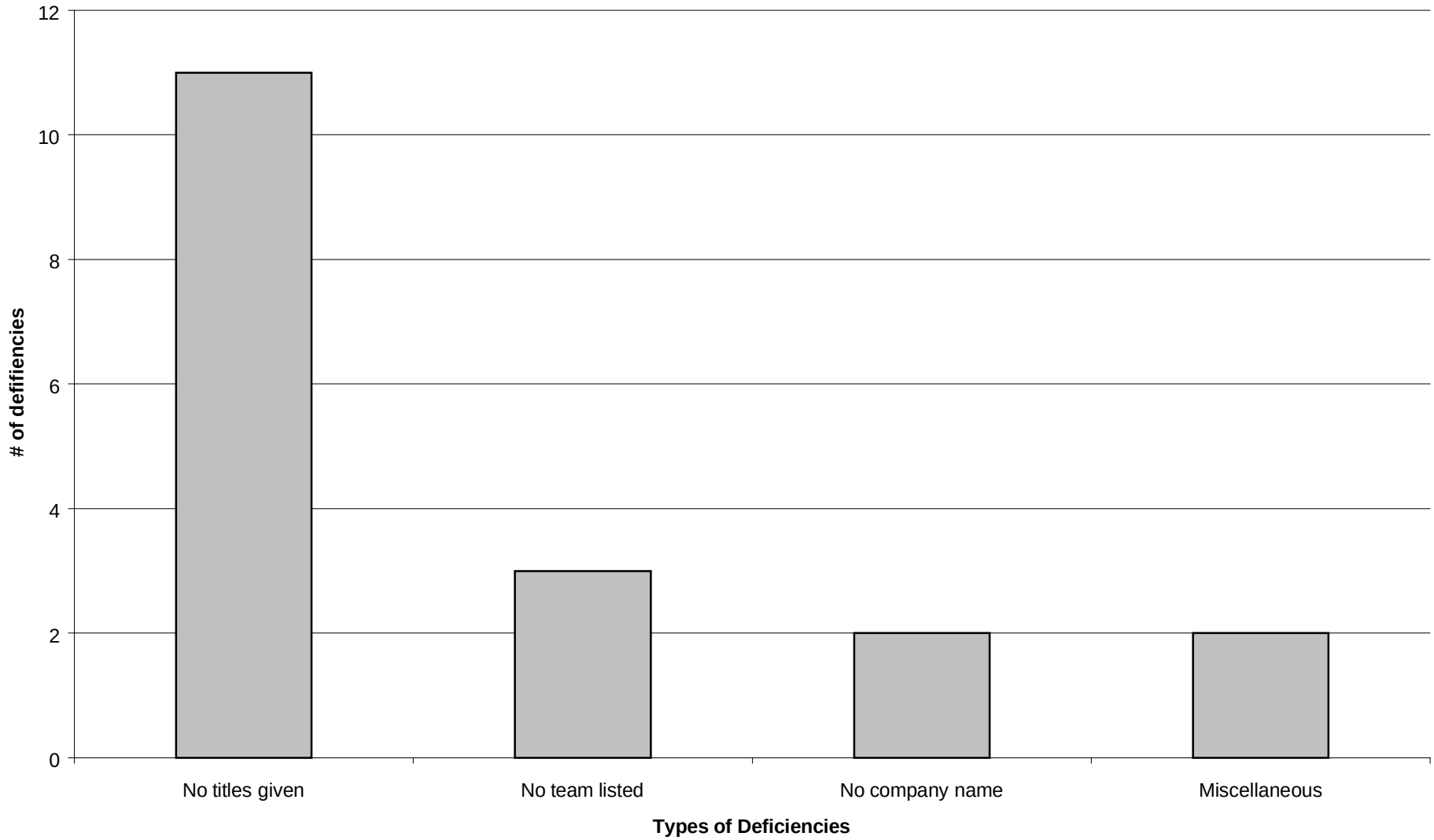

Figure 5 (Team members)
Deficiencies that were noted from 58 different plants assessed

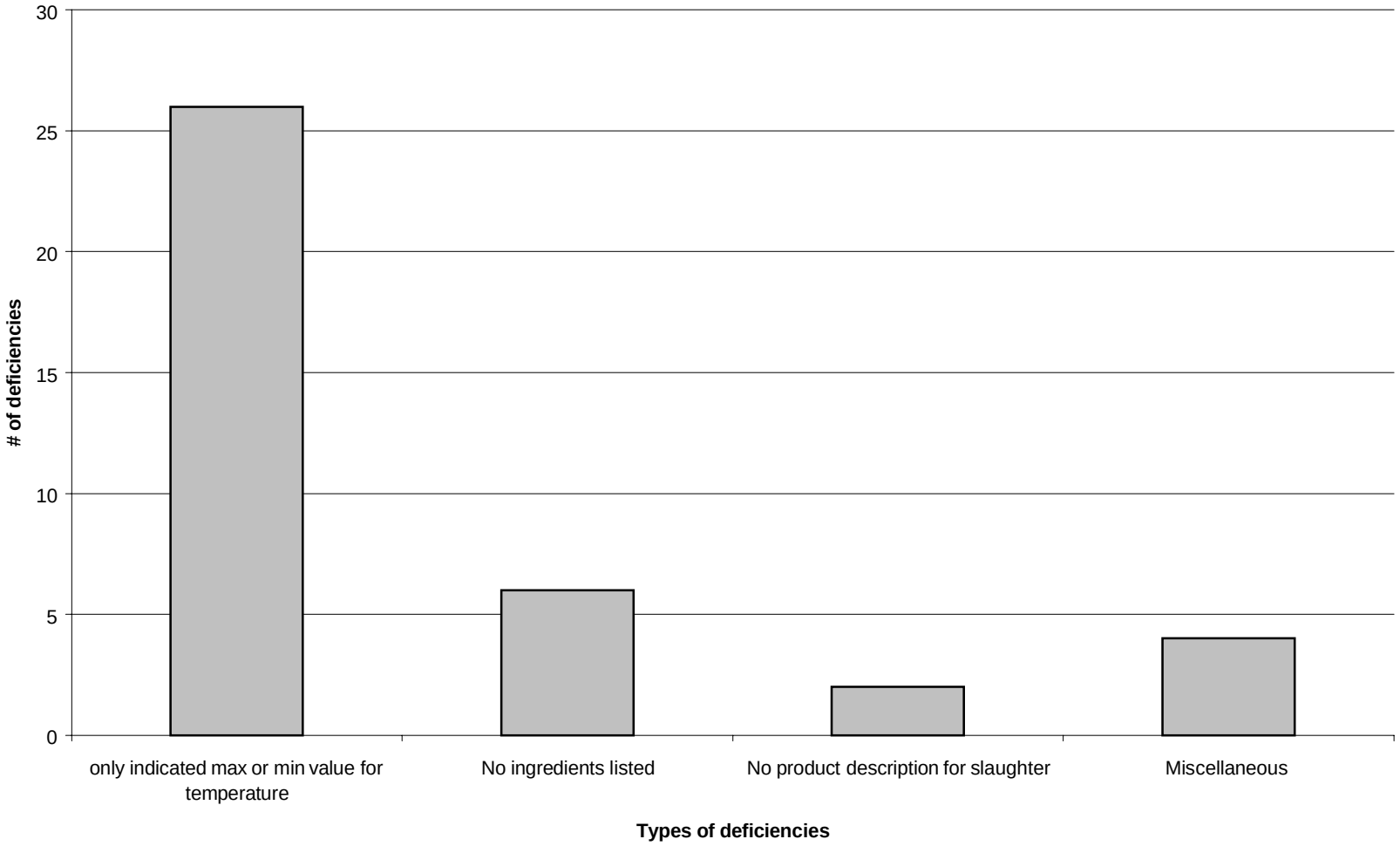

Figure 6 (Product description and Ingredients)
Deficiencies that were noted from 58 different plants assessed

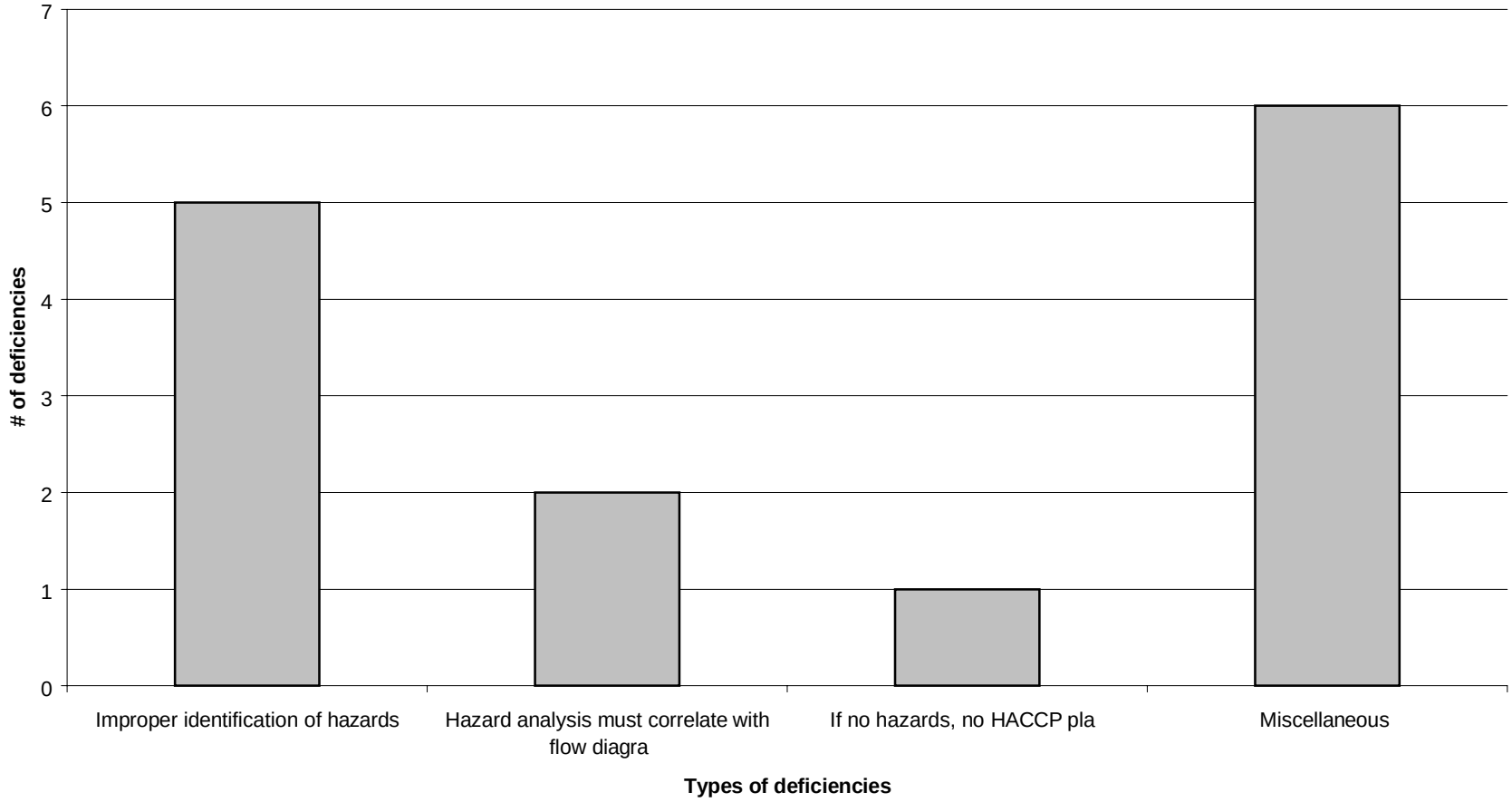

Figure 7 (Flow Diagram and Hazard Analysis)
Deficiencies that were noted from 58 different plants assessed

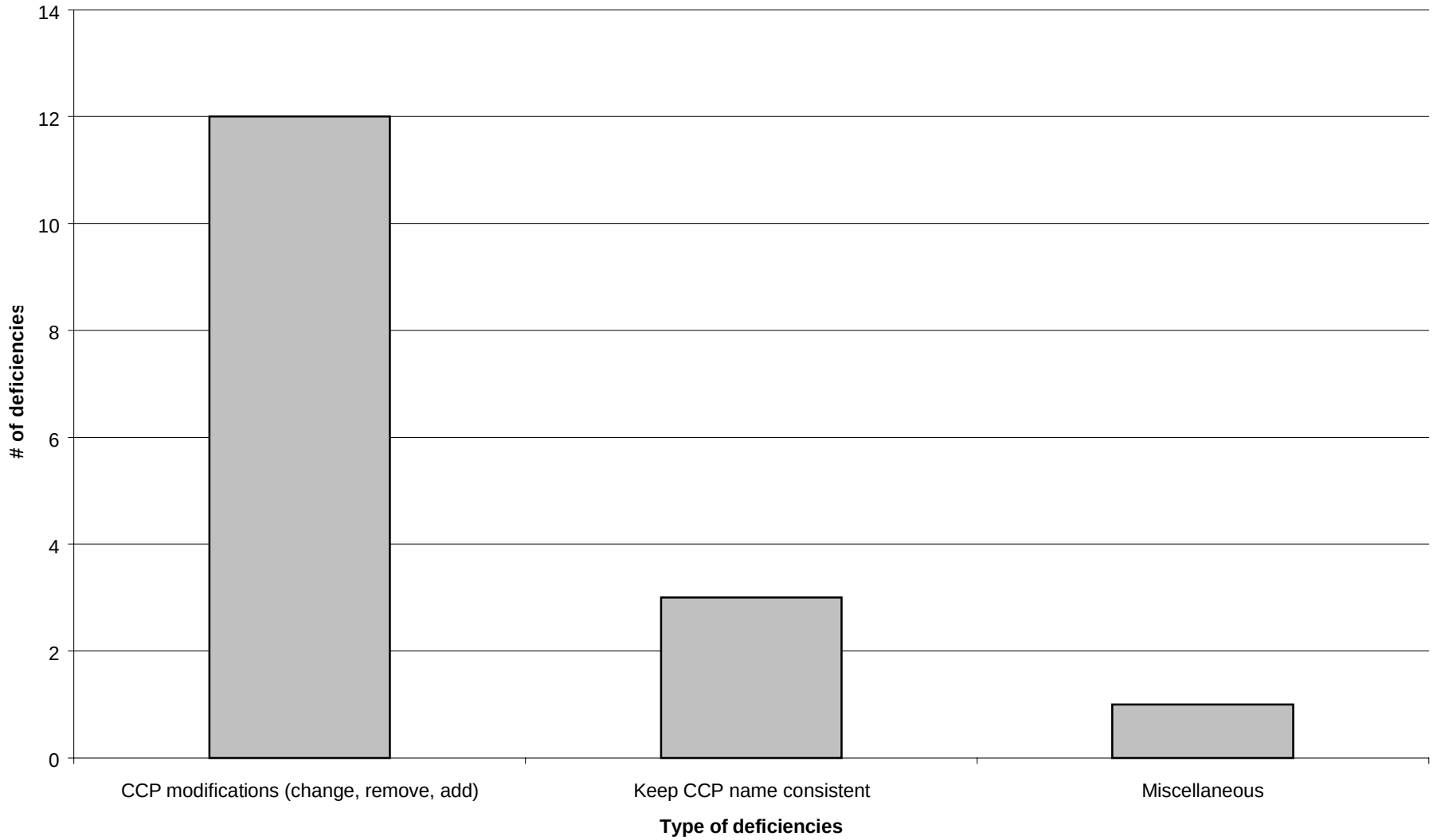

Figure 8 (Critical Control Points)
Deficiencies that were noted from 58 different plants assessed

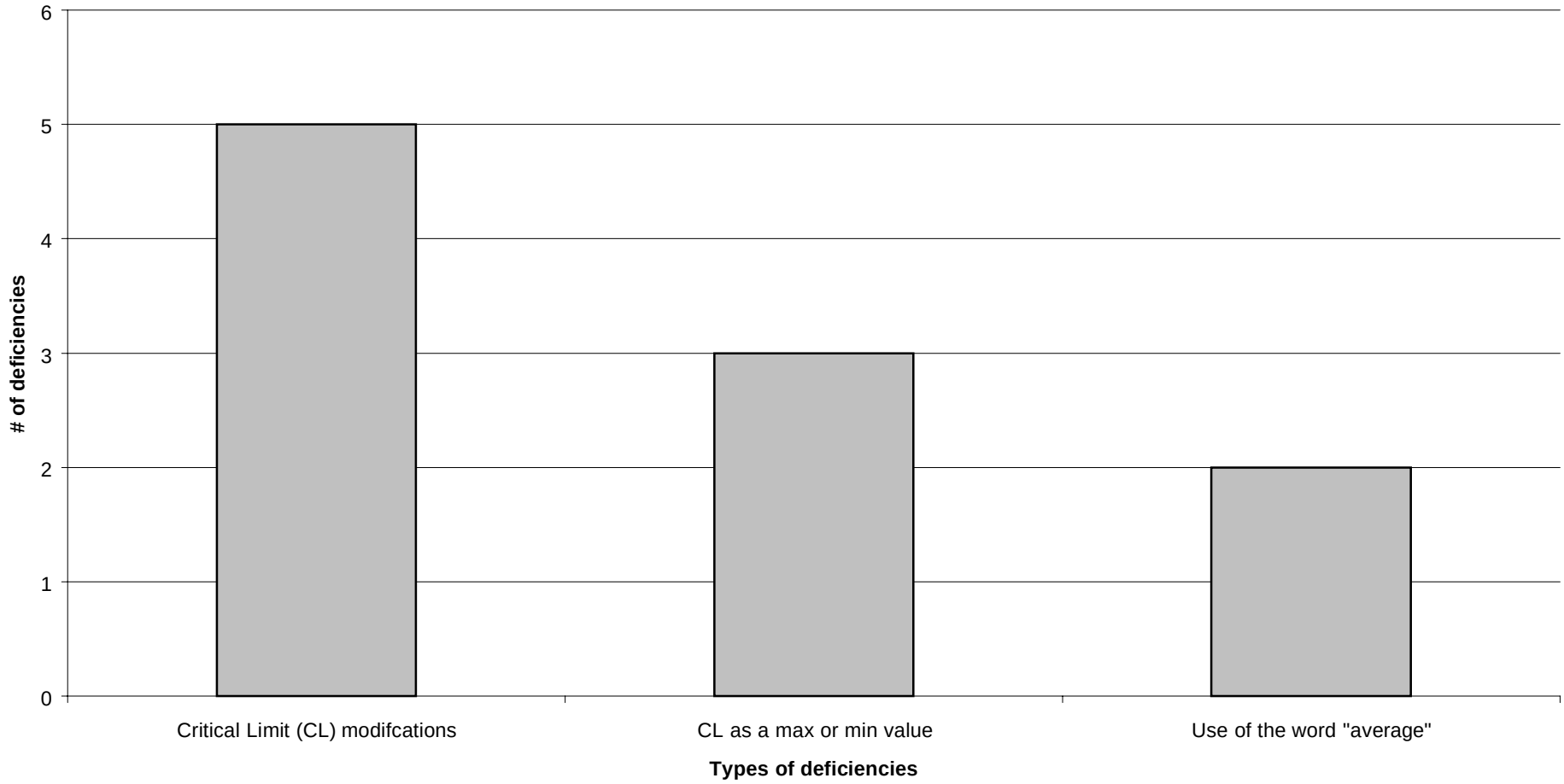

Figure 9 (Critical Limits)
Deficiencies that were noted from 58 different plants assessed

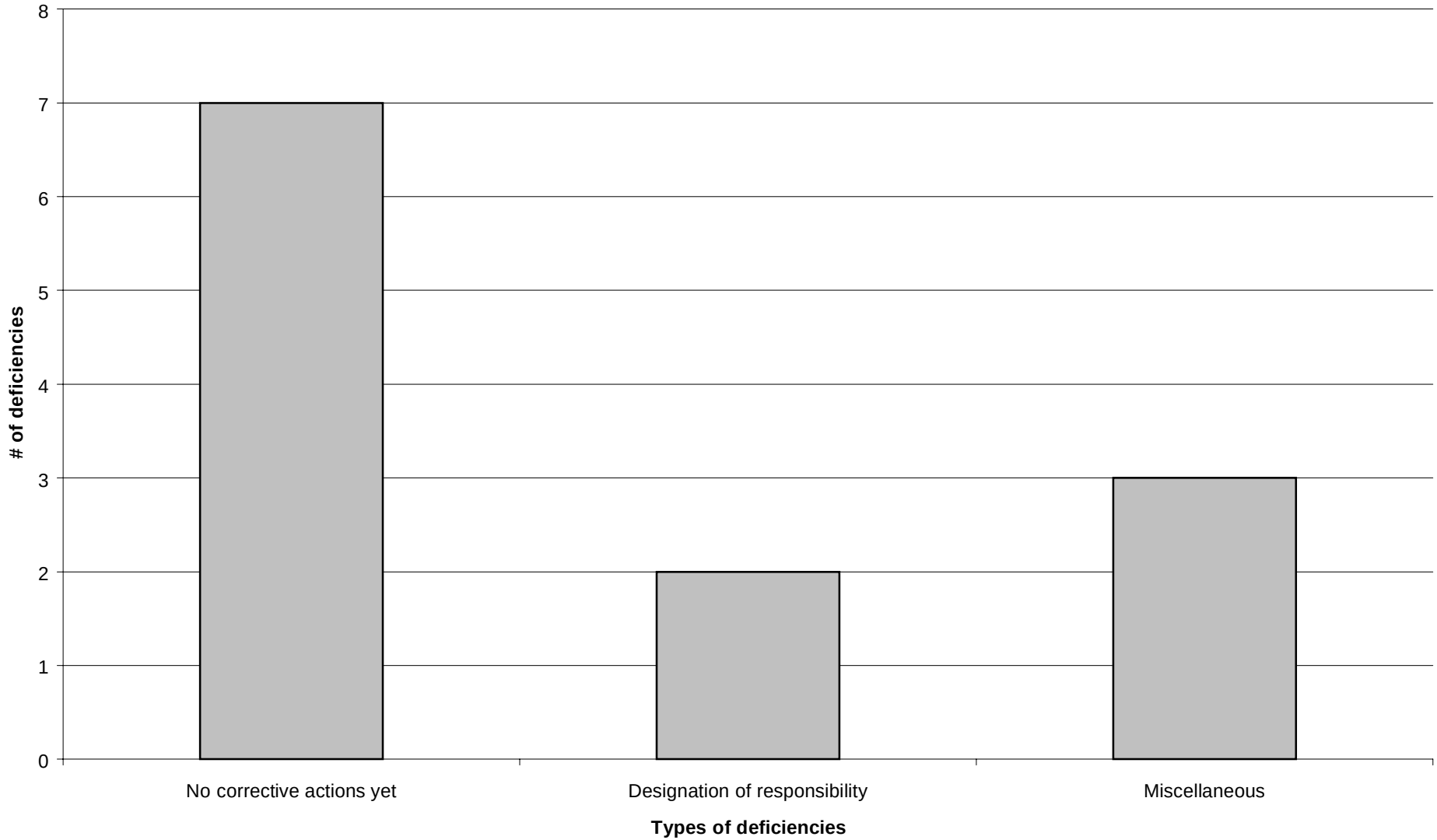

Figure 10 (Corrective Actions & monitoring)
Deficiencies that were noted from 58 different plants assessed

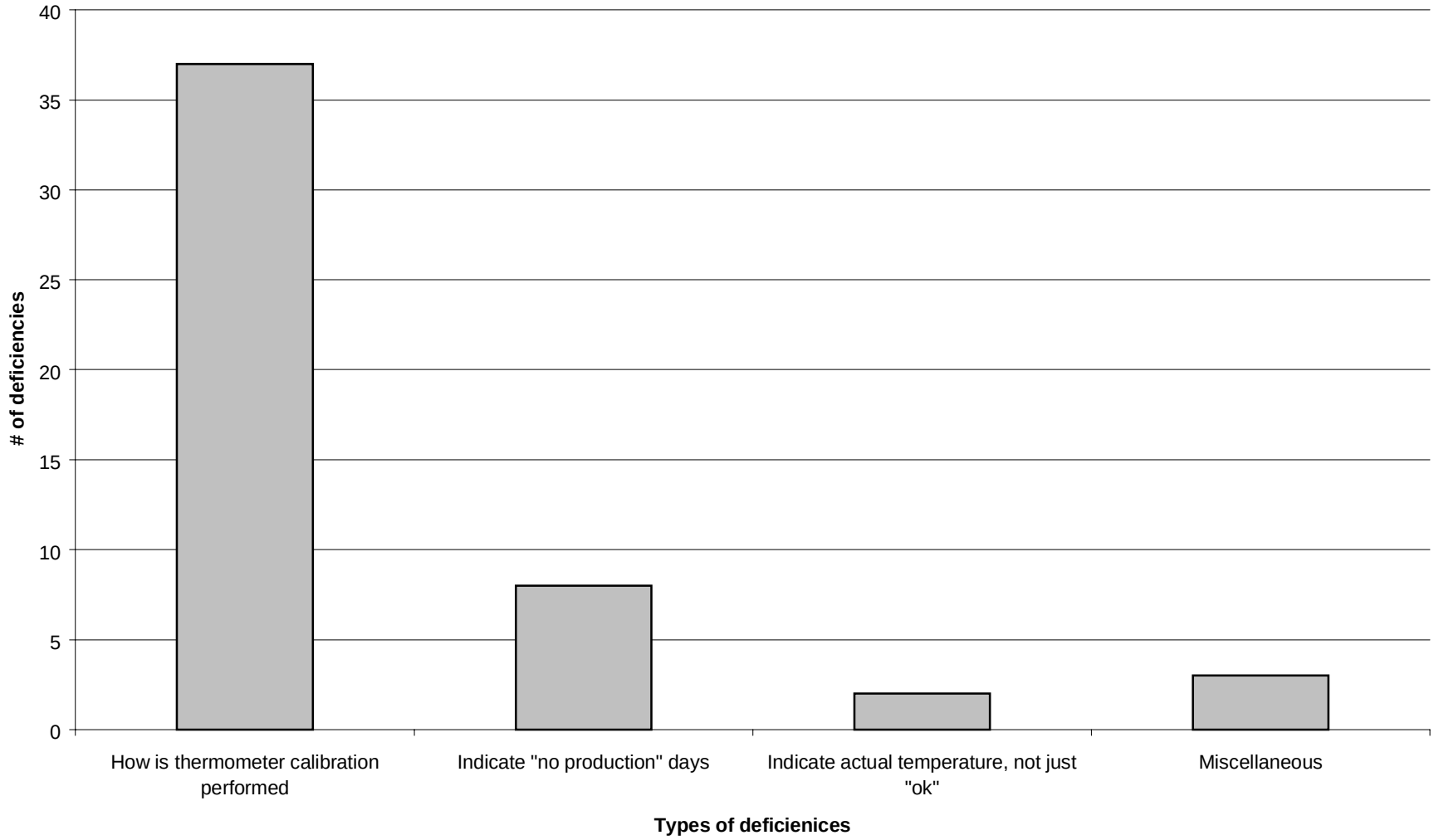

Figure 11 (Verification and Record Keeping)
Deficiencies that were noted from 58 different plants assessed

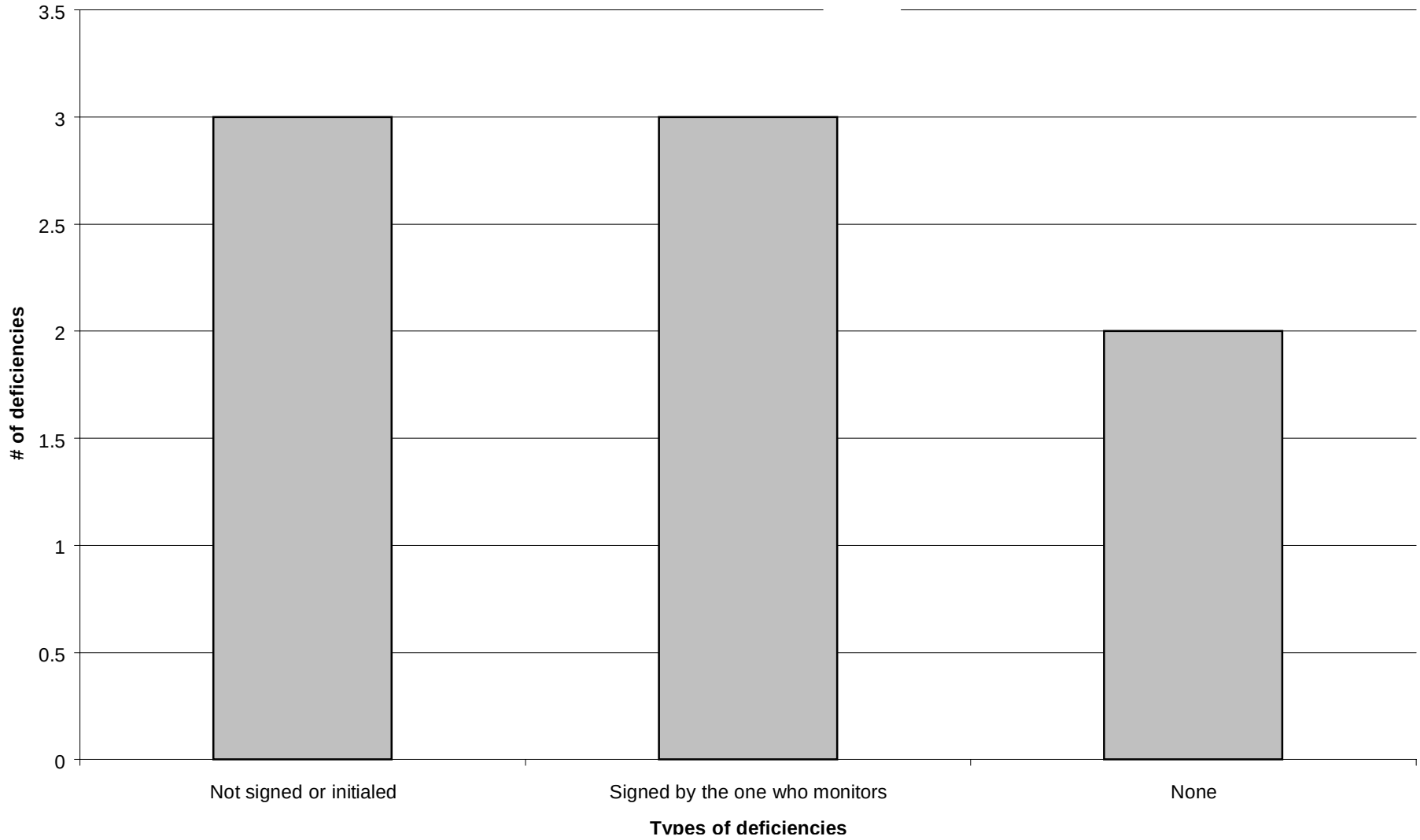

Figure 12 (Pre-shipment Review)
Deficiencies that were noted from 58 different plants assessed

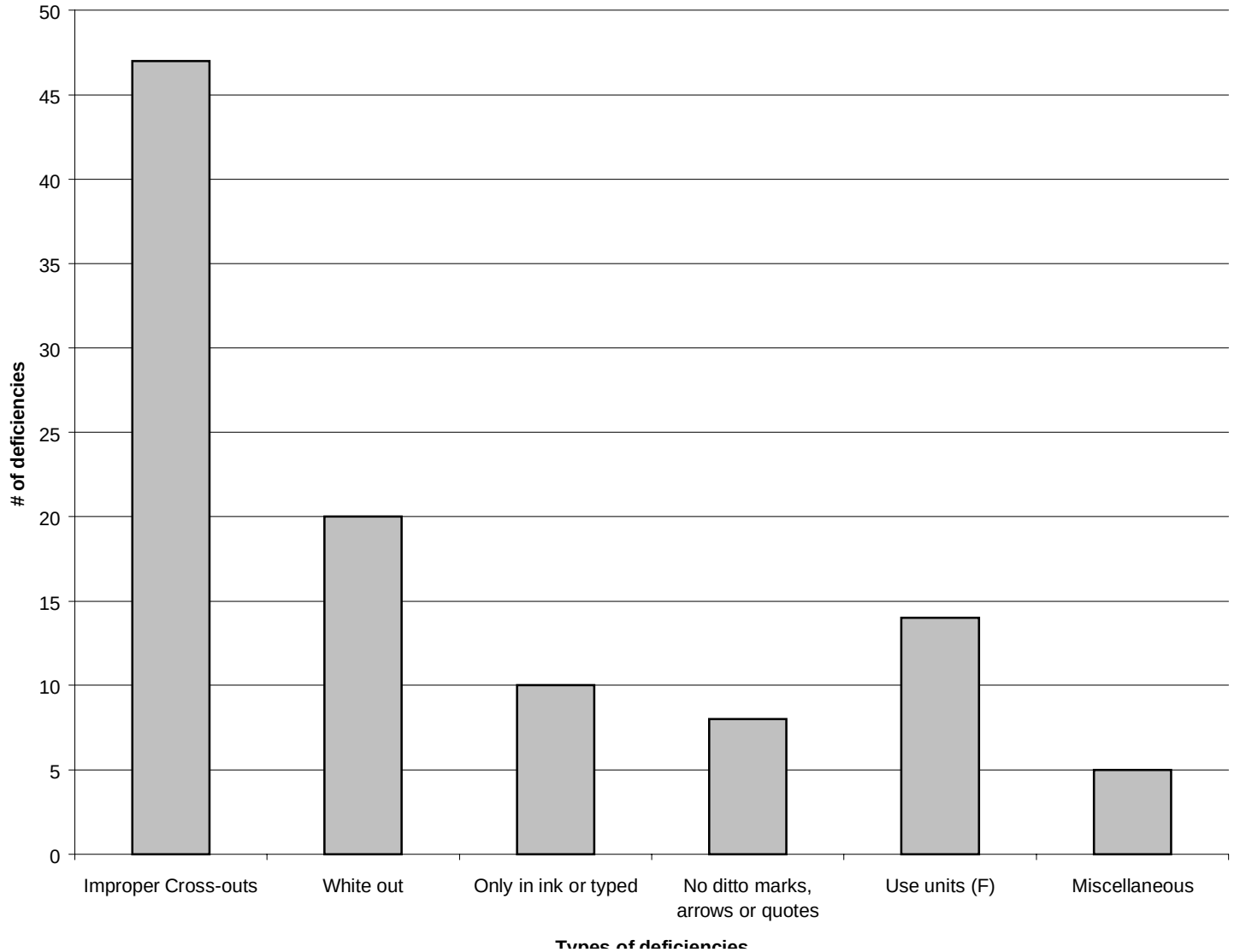

Figure 13 (Other deficiencies)
Deficiencies that were noted from 58 different plants assessed