

General Interest

Expedited Response to the Questions Posed by the United States Department of Agriculture Agricultural Marketing Service To Support Ground Beef Purchase for the Federal Food and Nutrition Assistance Programs^{†‡}

ADOPTED 28 MARCH 2012, WASHINGTON, DC
NATIONAL ADVISORY COMMITTEE ON MICROBIOLOGICAL CRITERIA FOR FOODS

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EXECUTIVE SUMMARY

The National Advisory Committee on Microbiological Criteria for Foods (NACMCF) or the Committee was on an expedited study timeline to provide recommendations to the United States Department of Agriculture–Agricultural Marketing Service (USDA-AMS) in order to assist the 2012 to 2013 school year purchase of beef products. The Committee’s recommendations address current USDA-AMS microbiological criteria (i.e., *Staphylococcus aureus* and *Escherichia coli* O157:H7), pathogen screen testing methodology, sampling plans, lotting and frequency of testing methodologies, and the reasons for the principle issues. The Committee agreed in the overarching conclusion that, regardless of adverse speculation relative to the USDA National School Lunch Program (NSLP), its food safety record for the past 10 years has been exemplary.

The specific charge to the Committee was to address the following three questions:

1. AMS is considering elimination of the requirement to test for *Staphylococcus aureus* from the Federal Purchase Ground Beef Program, and AMS asks NACMCF to provide considerations and scientific discussion regarding this action with respect to public health.

2. Should AMS consider the use of alternative screening procedures beyond those stipulated in the Food Safety and Inspection Service (FSIS) Microbiology Laboratory Guidebook (MLG), and if so, would the AMS testing program results be comparable to FSIS’s verification testing programs, and therefore useful to FSIS? What should be considered in distinguishing acceptable and unacceptable alternative screening procedures? Is it appropriate to allow alternative sample preparation procedures (portion size, enrichment broth, portion to broth ratio, enrichment time and temperature) which differed from the MLG or which differed by AMS designated laboratory (ADL)?
3. AMS asks NACMCF to evaluate boneless beef and finished product compliance program lotting and frequency of testing for pathogens and indicators of process control for both raw ground beef to be cooked on-site at schools with unknown cooking controls versus raw product destined to be cooked in a USDA-inspected establishment.

To address the questions the Committee studied the rationale and science used in the AMS program and reviewed the current science. The Committee makes the following recommendations.

Question 1

- The Committee has reviewed and concurred with recommendations of the National Research Council (NRC) report entitled “An Evaluation of the Food Safety Requirements of the Federal Purchase Ground Beef Program” (17), which finds “no scientific basis for including a *S. aureus* criterion in the AMS purchase specifications” and further recommends that the “criterion be removed from the Federal Purchase Ground Beef Program.”

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† Participating agencies include the U.S. Department of Agriculture, Food Safety and Inspection Service; U.S. Department of Health and Human Services, Food and Drug Administration, and Centers for Disease Control and Prevention; U.S. Department of Commerce, National Marine Fisheries Service; and U.S. Department of Defense, Veterinary Service Activity. This article may be reproduced without prior permission.

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Question 2

- AMS should consider the use of validated alternative screening methods to reduce the level of false-positive results and allow for more rapid release of raw product.
- Alternative screening methods must be validated against the FSIS MLG cultural method and must be compatible with FSIS MLG recommended confirmatory tests.
- Alternative screening methods should be: (i) validated by an independent certifying organization (AOAC-Official Methods of Analysis (OMA), AOAC-Performance Tested Method (PTM), Association Française de Normalization (AFNOR), MicroVal, or NordVal) or (ii) supported by a robust validation study using the FSIS cultural method as a reference method and approved for use by AMS in consultation with FSIS or (iii) those used by a regulatory body.
- After review of the current needs of AMS and due to the expedited review of the current charge, the Committee did not feel that there was sufficient time to make recommendations on alternative preparation and enrichment procedures. Therefore, the Committee recommends that AMS seek alternative screening methods to be used with the enrichment and confirmation procedures described in the MLG.
- Changes in preparation and enrichment procedures used by ADLs could be considered by AMS in the future provided appropriate validation studies are conducted in consultation with AMS, FSIS, and, potentially, the Agriculture Research Service (ARS).

Question 3

- Maintain high standards of supplier control, hazard analysis critical control point (HACCP) implementation, carcass testing, traceability, etc., as in current program. Each plant is subjected to verification audits conducted during production activities that demonstrate their adherence to the documented program.
- With the exception of eliminating *S. aureus* testing, no changes to testing of indicator organism types are recommended at this time.
- For boneless beef trim and ground beef intended for further processing in a USDA-FSIS-inspected facility using a validated cooking process with AMS oversight, testing for *E. coli* O157:H7 or *Salmonella* for disposition is unnecessary and should be discontinued.
- For product to be delivered to schools raw, boneless beef trim or ground beef lots which exceed any of the critical limits for *E. coli* O157:H7, *Salmonella*, or indicator organisms designated in Appendix B of the “Technical Requirements Schedule–BB-2010 for USDA Purchases of Fresh Chilled, Boneless Beef for Further Processing” (TRS-BB-2010) (22) and “Technical Requirements Schedule–GB-2010 for USDA Purchases of Ground Beef Items, Frozen” (TRS-GB-2010) (21) will be directed to a product line for cooking at a USDA-FSIS-inspected facility.

- For product to be delivered to schools raw, although the N60 sampling plan is more stringent than would be recommended when considering the documented compliance with food safety practices in the NSLP, AMS should continue N60 sampling for *E. coli* O157:H7 for boneless beef trim for two reasons. First, N60 testing is the accepted standard for USDA-FSIS sampling and commercial practices for nonintact beef. Second, diverting positive lots for cooking in USDA-FSIS-inspected facility using a validated cooking process with AMS oversight will remove these lots from the product stream delivered to the school system as raw and can serve to further reduce the risk of cross-contamination with ready-to-eat foods.
- For ground beef product destined for schools in raw form or for cooking in facilities outside AMS oversight, discontinue N8 whole-lot testing (N8 or a composite of eight random sample units per lot to create up to a 385-g sample per lot) but retain N4 for 1-h sublots (maximum of 10,000 lb [4,540 kg]; N4 or four random sample units for each 15 min of production composited into one analytical unit to create up to a 385-g sample per h). Each subplot found to be culture positive for *E. coli* O157:H7 plus the “shoulder” sublots on either side of the positive subplot will be diverted for cooking at a USDA-FSIS-inspected facility using a validated cooking process with AMS oversight for use in the AMS program.
- Continued testing of *Salmonella* (N5 for boneless beef per 2,000-lb [908-kg] combo bin; N4 for ground beef, 1-h subplot, 10,000-lb [4,540-kg] maximum; 25-g composite analytical unit) should be used to verify that intervention processes are controlled and as a factor to determine supplier eligibility; divert *Salmonella*-positive combo bins and sublots to cooking at a USDA-FSIS-inspected facility using a validated cooking process with AMS oversight for use in the AMS program to reduce the risk of cross-contamination with ready-to-eat foods at the school level.
- Use of all data collected for statistical process control (SPC) is suitable. AMS should continue its analyses of the options and factors mentioned by NACMCF. In addition, AMS should provide an updated report for 2013 with recommendations of scientifically supported implementations of a performance-based skip-lot sampling program and statistical process control practices as warranted.
- Regardless of sampling program, AMS should continue ongoing program reviews in consultation with FSIS and ARS to determine if any requirements need to be strengthened for supplier eligibility, processing, etc., including the use of additional or alternate intervention strategies.

BACKGROUND

The USDA-AMS, working with the Food Nutrition Service (FNS), the FSIS, and the Farm Service Agency, purchases and distributes ground beef for the federal food and nutrition programs. Such programs include the NSLP, food banks, emergency feeding programs, disaster relief

agencies, Indian reservations, and programs that serve the elderly.

Since the AMS program serves vulnerable populations in a wide variety of venues, it has been subjected to numerous internal and external reviews to ensure programmatic efficacy and operation adherence in accordance with sound science-based food safety principles. The latest program science review issued in 2010 was conducted by the NRC, Board on Agriculture and Natural Resources of the National Academy of Sciences (NAS) and is entitled “An Evaluation of the Food Safety Requirements of the Federal Purchase Ground Beef Program” (17). The aforementioned NAS report contains numerous findings and recommendations. One of the findings and its recommendation was:

Finding C2: In developing its current purchase specifications for ground beef, AMS did not follow a procedure based on the scientific principles described in the National Research Council, the International Commission on Microbiological Specifications for Foods (ICMSF), and Codex Alimentarius Commission (CAC).

Recommendation C2: AMS is encouraged to develop a systematic, transparent, and auditable system for modifying, reviewing, updating, and justifying purchasing specifications that are science-based—that is, specifications that are based on scientific principles as described in previous National Research Council, ICMSF, and CAC publications—and that state the expected public health benefits where appropriate. This would include specifying the use of pathogen detection methods that are among the most reliable available for use in related food safety programs. It may be appropriate for AMS to collaborate with ARS, FSIS, and CAC and potentially with other groups, such as NACMCF, to develop a risk-based system for assessing public health effects of purchasing specifications not just for frozen ground beef but for various products purchased by AMS for the NSLP and other programs.

As a result of the above recommendations and findings by NAS and others, the USDA-AMS requested that NACMCF address three specific questions listed below. It was well recognized that the complexity of the questions and the time available to perform an expedited study of the microbiological criteria as indicators of process control or insanitary conditions, the Committee could not completely finish the task. It was, therefore, decided that the Committee would address a set of additional questions from USDA-AMS regarding the study subject in the future.

ORIGINAL CHARGE TO THE COMMITTEE

Food Safety Questions from the USDA Agricultural Marketing Service to Support Ground Beef Purchase for the Federal Food and Nutrition Assistance Programs

The USDA-AMS purchases and distributes food for various federal food and nutrition programs that feed millions of Americans daily. USDA is committed to supplying safe, wholesome, and nutritious food to participants in these

programs. The NSLP is one of those programs. Ground beef is among the many items that USDA purchases under this program. AMS develops purchase specifications and conducts the purchases of the ground beef products for distribution through the FNS and the FSA.

In developing the food safety requirements of the Federal Ground Beef Purchase program, AMS uses an appropriate risk-based food safety strategy and the development and implementation of microbiological criteria based on scientific principles. In this regard, AMS asks the NACMCF to rigorously evaluate the microbiological criteria of the Agency’s ground beef purchase program and provide recommendations. AMS will seek NACMCF’s advice in two separate work charges. This request is the smaller and first of the two requests and represents AMS priority needs to assist their purchase of ground beef for the 2012 to 2013 school year. The larger work request will cover all food safety requirements of the Federal Ground Beef Purchase program and will be submitted to NACMCF at a later date.

Food suppliers to USDA must adhere to strict nutritional, food safety, and quality requirements. AMS uses a complete food safety strategy that encompasses more than the testing of samples to determine the safety and quality of the product. AMS ground beef purchase specifications go beyond industry food safety requirements mandated by the FSIS. Additional safeguard requirements include rigid time and temperature stipulations for the chilling and/or freezing of raw and finished product, tamper-evident packing, and additional facility inspections. AMS requires suppliers (raw material) and contractors (finished product) to the Federal Purchase Ground Beef Program to use statistical process control methods and requires product (raw material and finished product) to be tested for indicator organisms (aerobic plate counts [APCs], total coliforms, generic *E. coli*, and *S. aureus*) and pathogens (*E. coli* O157:H7 and *Salmonella*). AMS has a zero tolerance for the pathogens and defines the critical limits for each of the indicators. AMS’s food safety requirements can be found in the technical requirements schedule for ground beef (visit <http://www.ams.usda.gov/LSSTDZ> and click on the Federal Purchase Program Specifications link on the right-hand side in the “I want information on” box).

The requirements for the Federal Ground Beef Purchase Program are reviewed each year in order to continuously improve the quality and safety of the purchased products and overall program controls. As part of this process, AMS requests that NACMCF review current practices and develop specific recommendations concerning the issues outlined below.

Charge Questions for the Subcommittee

1. AMS is considering eliminating the requirement to test for *S. aureus* from the Federal Purchase Ground Beef Program, and AMS asks NACMCF to provide considerations and scientific discussion regarding this action with respect to public health.

TABLE 1. Summary of AMS ground beef test results for *S. aureus* for January 2007 through December 2011

| Year | No. of positive samples ^a | No. of samples tested | % positive samples | Maximum level (CFU/g) |
|------|--------------------------------------|-----------------------|--------------------|-----------------------|
| 2007 | 30 | 1,339 | 2.24 | 420 |
| 2008 | 28 | 2,247 | 1.25 | >1,500 ^b |
| 2009 | 14 | 1,161 | 1.21 | 60 |
| 2010 | 115 | 4,362 | 2.64 | 1,400 |
| 2011 | 224 | 11,402 ^c | 1.96 | 410 ^d |

^a Total number of samples positive (>10 CFU/g) for coagulase-positive *S. aureus* using Baird-Parker Plating method.

^b Dilutions to enumerate levels greater than 1,500 CFU/g were not performed.

^c Increased sampling in 2011 may be a response to media attention.

^d Partial data sets involving one laboratory.

- Should AMS consider the use of alternative screening procedures beyond those stipulated in the FSIS MLG, and if so, would the AMS testing program results be comparable to FSIS's verification testing programs and therefore useful to FSIS? What should be considered in distinguishing acceptable and unacceptable alternative screening procedures? Is it appropriate to allow alternative sample preparation procedures (portion size, enrichment broth, portion to broth ratio, enrichment time and temperature) which differed from the MLG or which differed by ADL?
- AMS asks NACMCF to evaluate boneless beef and finished product compliance program lotting and frequency of testing for pathogens and indicators of process control for both raw ground beef to be cooked on-site at schools with unknown cooking controls versus raw product destined to be cooked in a USDA-inspected establishment.

NACMCF RESPONSE TO QUESTIONS IN THE CHARGE

The questions have been addressed in the following order below. The responses to the questions are based on numerous discussions; the Committee's findings, conclusions, and recommendations are recorded for each question.

Question 1: AMS is considering eliminating the requirement to test for *S. aureus* from the Federal Purchase Ground Beef Program, and AMS asks NACMCF to provide considerations and scientific discussion regarding this action with respect to public health.

Findings

Although staphylococcal enterotoxins are an important public health concern, production of enterotoxins in amounts capable of causing illness does not occur until viable counts of at least 10^5 CFU/g are obtained in the food product (33). Considering that the minimum temperatures for growth (7°C [45°F]) and toxin production (10°C [50°F]) would likely not be exceeded during processing, it is improbable that toxin production will occur in contaminated ground beef to a level capable of causing illness (17). In fact, the Codex "Principles for the Establishment and Application of Microbiological Criteria for Foods" (6) states that microbiological limits should take into

consideration "the conditions under which the food is expected to be handled and consumed." Additionally, a final kill step (i.e., cooking) is required before ground beef products are consumed; the organism will not reach levels necessary to produce illness-causing amounts of heat-stable enterotoxin and therefore is not a significant risk factor.

Current literature does not support inclusion of microbiological criteria for testing for the presence of coagulase-positive *S. aureus*. For example, the ICMSF includes no requirement for testing ground beef for the presence or absence of coagulase-positive *S. aureus* (10). In addition, the NRC (18) states that limits for pathogenic microorganisms in microbiological criteria for raw meats are impractical; however, some companies include routine *S. aureus* testing as an indicator of insanitary processing. AMS utilizes a systems approach that controls not only acquisition of raw ingredients and processing but also AMS-FSIS conformance assessment to HACCP and other AMS processor eligibility requirements ensuring high quality and safety of the final ground product. AMS tests both the final product and the processing environment for other indicator organisms such as APCs, total coliforms, and generic *E. coli*. This testing is sufficient to detect insanitary processing or handling conditions that could introduce contamination by *S. aureus*.

S. aureus data provided by the AMS sampling program for the period of January 2007 through December 2011 (Table 1) clearly show that the ground beef samples analyzed yielded few positive results. Further, the maximum CFU per gram was significantly lower than that required to produce illness-causing amounts of enterotoxin.

The issue of methicillin-resistant *S. aureus* (MRSA) as an emerging public health concern was considered. MRSA is known for causing pyoderma and other soft tissue infections through cuts, wounds, and tissue abrasions. MRSA colonizes the skin, nasopharyngeal cavities, and other sites of both humans and animals possibly without evidence of infection. The Committee recognizes MRSA has been isolated from raw beef in the United States (Table 2) and Europe (14). Although cross-contamination with MRSA may be a pathway of concern in the future, at this time, ingestion is not a recognized pathway for MRSA infections; MRSA is not a relevant microorganism to be included in raw beef purchase specifications.

TABLE 2. Isolation of *S. aureus* and MRSA from retail ground beef samples

| No. of samples | No. (%) positive for <i>S. aureus</i> | No. (%) positive for MRSA | Sampling location | Reference |
|----------------|---------------------------------------|---------------------------|--|-----------|
| 156 | 32 (20.5) | 2 (1.3) | Detroit, MI | 3 |
| 29 | 2 (6.9) | 0 | Iowa | 8 |
| 198 | 55 (28) | 0 | Washington, DC | 13 |
| 30 | 6 (20) | 1 (3.3) | Baton Rouge, LA | 19 |
| 38 | 14 (37) | 1 (2.6) | Chicago, IL; Washington, DC; Fort Lauderdale, FL; Los Angeles, CA; Flagstaff, AZ | 36 |

Conclusions

- Based on the above information, the Committee concluded that the exclusion of *S. aureus*-specific testing will not negatively impact the safety or quality of ground beef in the NSLP.

Recommendations

- The Committee has reviewed and concurred with recommendations of the NRC report entitled “An Evaluation of the Food Safety Requirements of the Federal Purchase Ground Beef Program” (17), which finds “no scientific basis for including a *S. aureus* criterion in the AMS purchase specifications.” Further, the Committee recommends that the “criterion be removed from the Federal Purchase Ground Beef Program.”

Question 2: Should AMS consider the use of alternative screening procedures beyond those stipulated in the FSIS MLG, and if so, would the AMS testing program results be comparable to FSIS’s verification testing programs and therefore useful to FSIS? What should be considered in distinguishing acceptable and unacceptable alternative screening procedures? Is it appropriate to allow alternative sample preparation procedures (portion size, enrichment broth, portion to broth ratio, enrichment time and temperature) which differed from the MLG or which differed by ADL?

Findings

The AMS, at the recommendation of FSIS, currently requires ADLs contracted to conduct pathogen testing for the NSLP to adhere to the FSIS methods as described in MLG chapters 4 and 5 (26, 27), including the use of alternative screening methods described in MLG methods 4C and 5A. In its review of the Federal Ground Beef Purchase Program, AMS noted that the use of certain FSIS screening methods by ADLs has resulted in a number of false-positive results. For the purpose of this document, a false positive is defined as screen positive and/or indeterminate tests which are negative by the reference confirmatory procedure for the target pathogen. For example, the ADLs reported high levels of *E. coli* O157:H7 false positives with the BAX-MP test used as described in the MLG chapter 5A (27). The occurrence of false positives resulting from incorrect implementation of the BAX-MP,

improper interpretation of the BAX-MP data, or incorrect implementation of the FSIS confirmatory procedure (27) has been evaluated and addressed by AMS. These types of implementation problems alone do not account for the high rate of false positives that also have been observed by FSIS laboratories. A high false-positive rate is unacceptable when applied to 100% of lot testing as required by AMS because it takes an additional 2 to 4 days to get final confirmatory results prior to releasing raw product. Therefore, alternative screening methods may better meet the needs of the AMS-NSLP testing program.

The performance of alternative screening procedures should be determined in a validation study, with an appropriate confirmatory method to provide a definitive result. A validation study will evaluate many aspects of screening test performance including sensitivity, specificity, and recovery relative to a reference method but also repeatability, reproducibility, precision, ruggedness, and aspects of manufacturing quality. AOAC International and the International Organization for Standardization (ISO) have published guidelines on the validation of qualitative and quantitative microbiological methods (7, 11), and recognized certifying bodies organize validation studies under contract with screening test manufacturers to validate candidate methods (also called alternative methods). Regulatory agencies, including FSIS, the U.S. Food and Drug Administration—Center for Food Safety and Applied Nutrition (FDA-CFSAN), and the Canadian Food Inspection Agency, also published guidelines for validating methods used by government or by industry (4, 30, 35). An evaluation of alternative screening method performance should include validation of the method against the FSIS confirmation procedures as well as continued verification of the application of the method and laboratory performance (i.e., stringency of validation, multiagency review, and on-site audits).

The following options were considered by the Committee as potential alternative approaches for consideration by AMS in choosing alternative methods:

Option 1. ADLs employ an alternative enrichment and screening procedure of their choice as long as the procedure meets one of the following criteria:

- a. Used by a regulatory body.
- b. Validated by an independent certifying organization (AOAC-OMA, AOAC-PTM, AFNOR, MicroVal, or NordVal).
- c. Supported by a robust validation study using the FSIS cultural method as a reference method and

approved for use by AMS in consultation with FSIS. The FSIS confirmatory procedure would be used to confirm every screen test positive result. Therefore, enrichment conditions should be validated for use with respect to the appropriate FSIS confirmatory procedure, including the proper incubation period (e.g., 15 to 18 h for the *E. coli* O157:H7 method). This option would allow laboratories to use different procedures and could make it difficult for AMS auditors to verify the correct implementation of many different screening procedures, especially those with different enrichment conditions. For this reason, AMS may seek to limit the number of procedures that may be employed by ADLs.

Option 2. ADLs employ an alternative screening procedure that has been validated to perform suitably under the enrichment conditions specified in the MLG. AMS would specify that the MLG enrichment conditions, which include the portion size, enrichment broth, portion to broth ratio, and enrichment time and temperature, would be carried out by the ADLs. ADLs could choose screening methods that have been validated to perform acceptably under these conditions using the criteria described in Option 1. AMS may seek to limit the number of screening procedures employed by ADLs to ensure that auditors can verify the correct implementation of the method(s). Methods that have been used by a regulatory body or validated by an independent certifying organization could be modified to fit the FSIS enrichment conditions. In this case, a robust validation study could be provided to support these modifications, and the data would be reviewed by AMS and FSIS. Because the same enrichment conditions are used, the study may consist entirely of paired samples at the fractional recovery level which have been tested with both the alternative screening and confirmatory procedures. Note that many screening procedures have been validated for use after a shorter incubation period compared with FSIS. For example, some *E. coli* O157:H7 screening tests are employed after 6 to 8 h of incubation, in which case there could be insufficient opportunity for the target organism to grow to high enough levels to be captured by the screening test. In these cases, the reference confirmatory procedure would always be applied after an incubation period described in the MLG, not by the alternative procedure.

Option 3. ADLs employ two screening procedures in tandem to reduce the false-positive rate. This is a common strategy used in the beef industry to reduce false-positive rates. Under this strategy, if the second procedure is negative, no further analyses would be performed. If the second procedure is positive, the ADL may carry out cultural confirmation by following the FSIS MLG procedure. Screening procedures would be chosen by the ADL but should comply with criteria provided in Option 1. AMS may stipulate that the FSIS enrichment conditions specified in the MLG be used and may seek to limit the number of procedures used to develop this strategy. If this option were favored by

AMS, then FSIS would want assurance that the strategy would not increase the overall false-negative rate. For example, if the broths were not handled correctly, misidentified after the first test, or reenriched from the sample, the second test may fail to detect a truly positive sample. FSIS has provided guidance to industry on this issue (29). This FSIS guidance indicates:

- a. Screen positive results may be confirmed with cultural or noncultural test methods.
- b. Cultural confirmation procedures should adhere to the FSIS MLG method.
- c. Noncultural procedures should identify a different set of characteristics than the screening test (i.e., the same test used for screening or a similar test may not be reused to “confirm” the screening result).
- d. The second procedure should provide high sensitivity and enhanced specificity (i.e., ability to detect true negative results) compared with the screening test.
- e. Both tests should be demonstrated and documented to perform acceptably under the conditions of use, which includes the enrichment conditions for the screening test (e.g., portion size, enrichment broth, portion to broth ratio, and enrichment time and temperature). Acceptable performance is determined by validation, preferably through an independent organization.

Alternative methods meeting the criteria described in the above options would provide data that could continue to be useful to FSIS.

Conclusions

- Alternative screening procedures could be used by AMS laboratories provided they are validated for intended use and compatible with FSIS MLG confirmatory procedures.
- If alternative methods are demonstrated by validation to be equivalent to the FSIS cultural reference method, then the data would be useful to FSIS and would allow:
 - AMS data to be used directly by FSIS;
 - Direct comparison of specific company results between FSIS and AMS; and
 - FSIS to assist AMS in troubleshooting laboratory issues or problems with methods and method application.
- Additional time and data are necessary for the Committee to address the appropriateness of changes to enrichment and sample preparation procedures (including portion size, enrichment broth, portion to broth ratio, and enrichment time and temperature).
- Guidance is available from FSIS and from independent organizations (AOAC and ISO) on study design and procedures to evaluate and/or compare method performance (7, 11, 30).
- In addition to method validation, verification of the laboratory’s and analyst’s performance verification, multiagency review, and on-site audits are critical.

Recommendations

- AMS should consider the use of validated alternative screening methods to reduce the level of false-positive results and allow for more rapid release of raw product.
- Alternative screening methods must be validated against the MLG cultural method and must be compatible with the FSIS MLG recommended confirmatory tests.
- Alternative screening methods should be: (i) validated by an independent certifying organization (AOAC-OMA, AOAC-PTM, AFNOR, MicroVal, or NordVal) or (ii) supported by a robust validation study using the FSIS cultural method as a reference method and approved for use by AMS in consultation with FSIS or (iii) those used by a regulatory body.
- After review of the current needs of AMS and due to the expedited review of the current charge, the Committee did not feel that there was sufficient time to make recommendations on alternative preparation and enrichment procedures. Therefore, the Committee recommends that AMS seek alternative screening methods for use in combination with the enrichment and confirmation procedures described in the MLG.
- Changes in preparation and enrichment procedures used by ADLs could be considered by AMS in the future provided appropriate validation studies are conducted in consultation with AMS, FSIS, and, potentially, ARS.

Question 3: AMS asks NACMCF to evaluate boneless beef and finished product compliance program lotting and frequency of testing for pathogens and indicators of process control for both raw ground beef to be cooked on-site at schools with unknown cooking controls versus raw product destined to be cooked in a USDA-inspected establishment.

The agency representatives and the Committee agreed to change the wording in Question 3 submitted by USDA-AMS to allow for a more logical progression for discussion and resolution.

Clarified Question 3. *The Committee restructured Question 3 for ease of examination. AMS is requesting that NACMCF make recommendations on the testing of both raw material (boneless beef) and finished product (ground beef) based on intended use:*

- *finished product to be delivered to the school system (or designated facility) as a raw item and cooked within the school system or by an outside contractor but with cooking outside the oversight of AMS.*
- *finished product to be cooked at a USDA-FSIS-inspected establishment with AMS oversight and delivered as a cooked item to the school system.*

This request is a follow-up to the NAS study that found that the use of the same criteria for all applications is not consistent with Codex principle CAC/GL 21-1997 sec 2.3, which states, “when applying a microbiological criterion for assessing products, it is essential, in order to make the

best use of money and manpower, that only appropriate tests be applied (see subsection 5) to those foods and at those points in the food chain that offer maximum benefit in providing the consumer with a food that is safe and suitable for consumption” (6).

Considering this Codex principle, AMS requests NACMCF’s recommendation concerning (i) if the current AMS program testing requirements (lotting, frequency of inspection, and sampling plans utilized for pathogens and indicators) are sufficient for product delivered to the school as a raw item for further cooking, and (ii) could less stringent testing requirements be employed for product delivered to the school as a cooked item?

AMS asks NACMCF to evaluate the current way AMS uses microbiological results for process capability assessment. Is it more statistically valid for AMS to rely on one-in-five lot sampling for boneless beef results or all lots for process capability assessment? Regarding finished product process capability assessment, should AMS rely on the whole-lot results or the subplot results?

Findings

The Committee recognizes that when the prevalence of pathogens is very low in foods, it is impractical to test sufficient number of samples to provide confidence that a given lot of food is pathogen free. The purpose of microbiological testing in context of the products described in this charge is to verify the effectiveness of critical control procedures. These verification activities, including pathogen testing, “are more accurately conducted to verify the effectiveness of the process that will control hazards rather than to verify the safety of the food product” (2).

Federal Purchase Ground Beef Program description

AMS contracts with eligible suppliers to deliver fresh-chilled boneless beef for further processing and with grinders to deliver coarse ground beef, frozen bulk ground beef, and patties for the Federal Purchase Ground Beef Program. TRS-BB-2010 for USDA purchases of fresh chilled, boneless beef for further processing (22) and TRS-GB-2010 for USDA purchases of ground beef items, frozen describe the program. The cornerstone of this program is well-designed and implemented HACCP plans to ensure safety of the products. Among the requirements, the harvest process must include at least two pathogen intervention steps. One of the intervention steps must be a critical control point (CCP) in their FSIS-recognized harvest process HACCP plan, and the CCP intervention(s) must be scientifically validated to achieve a 3-log reduction of enteric pathogens. Carcasses must be routinely tested for Shiga toxinogenic *E. coli* (including O157:H7 and O157:nonmotile) to verify effectiveness of interventions.

According to AMS 2010 requirements, lots of boneless beef are identified as 2,000-lb [908-kg] combo bins (22). For each combo bin, 60 subsamples (N60) are randomly selected and composited to form a 325-g analytical unit for *E. coli* O157:H7 detection in accordance with FSIS Directive 10,010.1 Revision 3 (28). Five subsamples (N5) are composited to assay for the presence of *Salmonella*

(25-g enrichments), and five subsamples (N5) are composited to assay for other indicator organisms per limits identified in Appendix B of TRS-BB-2010 (22). Ground beef is tested using both whole-lot testing (identified as cleanup to cleanup; composite sample N8) and subplot testing (identified as 1-h period not to exceed 10,000 lb [4,540 kg]); composite sample (one sample collected every 15 min for a composite of N4 per hour) critical limits for pathogens and indicator organisms are identical to those for boneless beef (21). Lot definition for boneless beef (i.e., 2,000-lb [908-kg] combo bins) and collection of ground beef samples every 15 min are similar to practices used by many entities in the commercial industry (2).

AMS provides two product streams: ground beef products sent to schools in cooked form and products sent to schools in raw form that the receiving schools either cook or contract to have cooked. AMS purchases raw beef in different pack sizes for different intended uses. The packs sized for sending to school food service, including 10-lb [4.5-kg] chubs of ground beef and 40-lb [18-kg] cases of frozen patties, are intended to be cooked by the schools. The bulk-size packs are intended for diversion to further processors for conversion into a finished end product. The state or school district diverting the product to the processor chooses the processor and finished end product. Although most of the finished end products are fully cooked, a few, such as wafer steaks, are not. According to USDA FNS regulations, "all of the processing shall be performed in plants under continuous Federal meat or poultry inspection, or continuous State meat or poultry inspection in States certified to have programs at least equal to the Federal inspection programs" (23, 24). AMS also purchases a small proportion of beef for schools as a cooked product. The bulk product and the product purchased in cooked form together make up the ground beef products that are sent to schools in cooked form.

1. Ground beef (and boneless trim used to produce the ground product), which is processed in a USDA-FSIS-inspected facility using a validated cook step verified by the USDA-FSIS and sent to schools in cooked form.
 - a. This product category represents about 60 to 80% of beef; the percentage varies depending on the year and is affected by the cost of beef, nutritional requirements, and trends for products that use ground beef.
 - b. A validated cooking process for ground beef conducted in a USDA-FSIS-inspected facility with oversight by AMS destroys any pathogens that may be present in the product. Testing for pathogens in the raw ingredients intended for a validated lethality step is deemed unnecessary by the scientific community (9, 10, 17); pathogen testing in raw ingredients is not required for other commodities (e.g., pasteurized milk, juice, fermented sausage, and almonds).
2. Ground beef sent as raw product to the schools will also have a validated cooking process; however, this

cooking process will be conducted outside AMS oversight. The schools will cook the product on-site or have it cooked at a central kitchen, or the school will contract USDA-FSIS or state-inspected facilities to cook the product.

- a. This product category represents about 20 to 40% of beef.
- b. A food safety plan based on HACCP principles is required by USDA for school food service. Food Code requires cooking of raw ground beef to 155°F (68°C) for 15 s or other time-temperature combinations based on previous NACMCF opinions (33), and compliance with these requirements is high. However, because some of this product is sent to the school raw and processed on-site, there is risk of cross-contamination, and because the final lethality step is conducted without direct oversight of USDA, the microbiological testing of this product should have greater stringency.

Prevalence of *Salmonella* and *E. coli* O157:H7

Currently, when the presence of *Salmonella* or *E. coli* O157:H7 is identified or any critical limit is exceeded for indicator microbes, FSIS and AMS are notified, and the production lot is not allowed in any USDA-AMS product. A breakdown of data for the period July 2011 through February 2012 revealed 0.93 and 0.06% of 11,454 ground beef lots were positive for *Salmonella* and *E. coli* O157:H7, respectively, whereas 0.46 and 0.02% of 54,847 boneless beef combo bins were positive for the two pathogens, respectively. Note: This is a lot-positive rate based on percent-positive composite test results and not a rate of individual pieces that make up the composite. The incidence of *Salmonella* in AMS products is less than the 2.2% rate of *Salmonella* in ground beef identified in 2010 FSIS survey data and less than the 7.5% baseline rate for *Salmonella* allowed for process control (31) in that commodity. The low incidence in AMS samples is attributed to the total safety system required of the suppliers and processors of product for the AMS ground beef program.

The frequency and type of sampling and testing of the boneless trim and ground beef produced for AMS should be based on whether the commodity will be subjected to a validated cook step under USDA-FSIS oversight or sent to the end user in a raw form. USDA-FSIS-inspected facilities contracted by AMS utilize a validated cook step and operate under a USDA-FSIS verifiable HACCP plan. School lunch programs are similarly required to have a HACCP program and to cook raw animal products in accordance with Food Code or to contract with state-inspected or FSIS-inspected cooking facilities; however, in the latter situation, the lethality step occurs outside of AMS oversight.

The NSLP has a remarkable food safety record during the past decade. The Child Nutrition and WIC Reauthorization Act of 2004 required school food authorities to implement a food safety program based on HACCP principles for the preparation and service of school meals served to children in the school year beginning 1 July 2005

(23). HACCP is required in all facilities, including central, heat-and-serve, and cook-on-site kitchens. Components of HACCP include, but are not limited to, training, monitoring, corrective actions, and record keeping. With relationship to raw ground beef products, validated cooking to 155°F (68°C) for 15 s is specified by Food Code (33). Training and longevity of staff results in high compliance for cooking of raw animal products (e.g., beef, poultry, and eggs). Although an FDA study of food handling practices in elementary schools found that noncompliance for reheating has been identified in school inspections, no violations were observed for failing to meet cooking requirements. Nevertheless, there were noted observations on possibilities for cross-contamination venues (34).

Investigation of outbreaks of *E. coli* O157:H7 infection in schools have demonstrated no epidemiological evidence of illness associated with raw beef products since the institution of HACCP programs in schools in 2005 (5). From 2000 through 2004, ground beef was identified as the likely contaminated food in three *E. coli* O157:H7 infection outbreaks that occurred in schools (two in 2000 and one in 2003), but it was “unclear whether the ground beef was obtained through the Federal Purchase Ground Beef Program” (17). Similarly, no confirmed *Salmonella* outbreaks in schools during 1998 through 2010 were associated with ground beef (5).

Considerations for basis of sampling plans

Microbial testing of boneless beef trim and ground beef frequency depends on the target organism and product types. As recommended by the NAS NRC Committee (17), “AMS is encouraged to develop science-based approaches for proper use of raw materials that do not meet its specifications.” When testing finds that a product lot does not meet AMS specifications for pathogens (e.g., positive for *E. coli* O157:H7 or *Salmonella*), the lot should be directed into a product line with USDA-FSIS-inspected cooking instead of being removed completely from the AMS Federal Purchase Ground Beef Program. Thus, FSIS would provide an AMS mechanism for assuring safe disposition of potentially unsafe product (17).

Testing for indicator organisms identified in Appendix B of TRS-BB-2010 (22) and TRS-GB-2010 (21) is used to verify that the boneless beef and ground meat supply and processing are in control and their quality meets specifications.

Intensive testing of boneless beef trim for *E. coli* O157:H7 is designed to divert contaminated product; N60 sampling for boneless trim is in accordance with FSIS Directive 10,010.1 Revision 3 (28) and is the currently accepted industry-wide standard.

In boneless beef, *Salmonella* is tested at a lower rate of sampling (N5) composited to provide a 25-g analytical unit. FSIS deems *Salmonella* testing as a performance standard to verify that plant HACCP systems are effective in reducing contamination with this pathogenic microorganism. Under the 1996 “Pathogen Reduction; Hazard Analysis and Critical Control Point (HACCP) Systems, Final Rule” (25), FSIS established *Salmonella* performance standards

for several raw product classes as a means of verifying that establishments control food safety hazards in fresh meat processing. FSIS verifies the performance standards by conducting the *Salmonella* verification testing program, in which FSIS samples and analyzes sets of chilled carcasses for *Salmonella*. Current FSIS performance standards for ground beef (31) are based on an estimated national product prevalence of 7.5%, an acknowledgment that it is not feasible to eliminate the pathogen completely in raw ground beef.

Beginning in 2010, AMS program sampling and testing of ground beef for *E. coli* O157:H7 was increased from N8 whole-lot testing (cleanup to cleanup) by adding N4 hourly subplot testing by sampling every 15 min and compositing four samples into analytical units representing 1 h of production. The high degree of compliance with HACCP in the NSLP, particularly with cooking raw ground beef, and the lack of evidence that the N8 whole-lot sample reduced foodborne illness in schools suggest that continuing both the whole-lot and subplot testing for product disposition of ground beef is not warranted. The AMS subplot testing plan provides greater ability to detect contamination during an 8-h shift than the AMS whole-lot testing plan. This is because more individual samples are collected (32 versus 8 individual samples per 8-h shift), and more 325-g composites are tested for the presence of *E. coli* O157:H7 (eight versus one portion per 8-h shift). Other things being equal, a larger size of each subsample would be expected to have higher prevalence. For example, based on the overall AMS raw ground beef positive rate of 0.06% (and assuming contamination was Poisson distributed), N8 subsamples (40.6 g each) would have an apparent prevalence of 0.01% and N4 subsamples (81.3 g each) would have an apparent prevalence of 0.02%. Based on an overall capability to detect *E. coli* O157:H7 in ground beef over the course of an 8-h shift, hourly N4 subplot testing offers an advantage over N8 sampling. An examination of data for the period July 2011 through February 2012 revealed that no whole-lot (N8) sample was positive for *E. coli* O157:H7 (out of 1,136 samples) while 7 subplot samples were positive for *E. coli* O157:H7 (out of 10,318 samples).

The AMS program currently requires both whole-lot and subplot testing, so a program lacking either plan would reflect less sampling than the current program; however, the incremental public health benefits of each testing program cannot be estimated with high degree of confidence on the basis of available scientific data. In the Committee’s judgment, the current testing programs are redundant. Removal of the whole-lot testing plan would have minimal effect on the ability to detect contamination during the course of an 8-h shift when compared with the removal of the subplot testing plan. An important difference between plans is the volume of ground beef represented by a composite test result “cleanup to cleanup” for the whole-lot testing plan versus 1 h of production (not to exceed 10,000 lb [4,540 kg]) for the subplot plan. This means that producers confronted with a N4 subplot-positive result may not consider all ground beef produced on the grinding equipment during a day to be adulterated and therefore

diverted to cooking or other endpoints as required by the FSIS. Per AMS guidance, producers would divert three sublots: the subplot testing positive plus the sublots produced on the same equipment before and after the positive subplot. A recent study on kinetics of *E. coli* passage at ground beef processing supports this practice (15).

Sampling plans have been recommended based on the potential for the risk to increase, decrease, or remain the same and the severity of pathogen consequence (10). More stringent sampling plans are generally recommended as the potential risk increases and the severity of the hazard increases, including foods intended for sensitive populations (e.g., baby food, dietetic food, hospital foods, foods for AIDS patients, and relief foods). A point that is frequently overlooked is that ICMSF sampling plans are intended to be used when there is limited or no information on the processes used to produce the food. Application of good manufacturing practices and HACCP plans for process control provides more useful information for effective food safety management. Therefore, reduced sampling frequency, sample size, and sample number may be scientifically appropriate when information on the process is available, such as the program managed by AMS. Furthermore, the level of control achieved in implementation depends not only on the frequency and level of sampling but also on the incentives for compliance and the consequences of noncompliance. Therefore, identifying an appropriate sampling plan is not purely a statistical matter.

The Committee considered school-aged children as a "sensitive population"; hence, more stringent requirements, including sampling plans, may be considered to help assure safety and public confidence. However, the cost of such programs must be weighed against the cost of buying the food needed to support the program. NACMCF will not assess this management decision; however, it will comment on the information available related to food safety. According to USDA-FNS regulations, schools receiving AMS beef through NSLP must have a food safety plan based on HACCP principles that conforms to their state and local Food Code requirements (23). Food Code section 3-8 prohibits serving rare meat to susceptible populations, including children (33). An FDA study (34) reported that for elementary schools "management systems that were implemented to ensure foods were adequately cooked . . . appeared to be effective during this data collection period." This suggests that cooking in the school is reliable and sufficient to reduce hazard associated with *E. coli* O157:H7 and *Salmonella* to an acceptable level, and epidemiological data (i.e., lack of outbreaks associated with ground beef products in schools) support this conclusion. Therefore, the sampling that is done by AMS provides verification of effective food safety measures on the part of the supplier, but AMS, in consultation with FSIS and ARS, could consider reducing sampling without compromising safety. Although the probability of detecting a defective lot is increased with greater number of random samples taken, all the sampling plans identified in this document have limitations (i.e., testing cannot guarantee the absence of a pathogen).

For the purpose of testing beef trim lots, the effect of increasing sampling from N60 to N120 to detect *E. coli* O157:H7 was calculated. Based on a 325-g composite, the FSIS baseline product prevalence estimate for *E. coli* O157:H7 in beef trim was 0.68%. Assuming the level of *E. coli* O157:H7 in raw ground beef is Poisson distributed, this implies that for N60 sampling based on a 325-g composite, the prevalence of individual beef trim sample units (averaging 5.4 g) within lots is approximately 0.011%. The probability of detecting the pathogen at this level of contamination for N120 sampling (650 g) is 1.36%. At this low level of contamination, one would need to test 26,343 such beef trim sample units (142.69 kg) to have 95% probability of detecting the pathogen. Therefore, the impact of testing to detect *E. coli* O157:H7 is severely limited as a direct control measure. This strongly reinforces the need to focus on validated kill steps and verified HACCP process controls for the whole production system.

Use of skip-lot testing for process capability assessment

AMS testing of product presented from contracted suppliers for sale in the NSLP currently uses both acceptance sampling and SPC. Across the various products, the AMS currently uses lot disposition criteria (acceptance sampling), control charts, and certain features of skip-lot sampling in different parts of their overall approach to ensure the food is safe.

Traditional skip-lot testing is used when product is generally considered to be of consistently good quality (1, 12, 16). These testing plans typically have three parts: (i) qualification when initial requirements are met, usually by passing every-lot inspection for a specified number of lots; (ii) skip-lot testing that starts with testing every other lot, then can change progressively to reduce testing to one in every five lots with exemplary testing results demonstrated; (iib) an increase in the frequency of skip-lot testing (i.e., from one-in-three-lot testing to every-other-lot testing) if results do not meet the criteria to remain in the less frequent testing state, until such time as the results again warrant a reduction in the rate of testing; and (iii) disqualification from skip-lot testing and requiring every-lot testing based on poor test results. Current AMS testing uses modified skip-lot testing as part of the SPC program in that every lot is tested to determine lot disposition (acceptance or rejection), but not all test results are chosen for SPC verification.

Boneless beef establishments whose tests do not meet certain parameters in the SPC plan are placed into a conditional plan, but neither the testing frequency nor the rate of inclusion in the SPC calculations are increased. That is, one test result of every five is included for SPC evaluation in the conditional period. Poor results in the conditional period then lead to exclusion from the program until such time as the establishment provides ample justification to resume. This justification is evaluated on a case-by-case basis.

The current AMS approach (21) in ground beef ignores the sample results of individual sublots in SPC determinations; however, subplot testing is used in determining

disposition of some of the product in a full day's production. All product in the sublots that have unacceptable results, as well as both the subplot immediately preceding and the subplot immediately succeeding the unacceptable subplot, are excluded from the product ultimately included in the whole lot.

This situation is similar to compositing samples. Whereas individual samples provide more information on separate sampling locations or projects, composited samples save resources and represent broader definitions of "lots." However, because no resources are saved here, the advantage of using the "whole-lot" testing is in gauging day-to-day variability while sacrificing to some extent hour-to-hour variability. Further data analysis is necessary to determine the extent of variation from hour to hour.

SPC charts results over time and requires corrections to processes any time the results are outside the control limits. Typically, an individual producer or corporation would set the upper and (where applicable) lower control limits based on that company's specific production processes and capabilities (20). There are several instances where a uniform set of parameters set across all producers or suppliers may be warranted. Customers of FSIS-inspected establishments set up prerequisite programs with the supplying establishments to ensure supplies meet the customer's criteria. In these instances acceptance sampling procedures, such as those found in the U.S. military's "DOD Preferred Methods for Acceptance of Product" (32), can be used.

Because the products in question with the AMS program are distributed to school children, who have a higher proportion of vulnerable individuals than the adult population, uniform national parameters would be expected. Further data analysis is needed to guide whether the parameters established by AMS should be revised. The SPC used in AMS's program for ground beef consists of results from the last 20 "whole-lot" tests (i.e., test results from the eight subsamples throughout a production day). One consideration in this situation is whether it would be beneficial to conduct the SPC evaluation on these "whole-lot samples" or on the individual sublots. Ground beef test results provided by AMS from nine establishments showed that at least six establishments presented 13 sublots on at least 1 day between July 2011 and January 2012 (inclusive). Given this situation and the 20-lot SPC evaluation period, an establishment could conceivably test outside acceptable parameters at the beginning of a day and then have 20 acceptable results by the end of the next day. Hourly results are useful for SPC if the results of the testing are received quickly enough to adjust production parameters. However, given the logistics of collecting, shipping, testing, and reporting the results from testing, it is several days before the results are known. Therefore, the parameters for the control charts need to incorporate several days of tests to properly gauge an establishment's process control. That is, for a large producer, the 20-sample window may be too short. A given establishment could be shifting in and out of process control before it is determined whether a previous day's results were acceptable or not. Further analysis of AMS data and the statistical properties necessary for SPC are needed to set the

window length and corresponding failure parameters. AMS should work to analyze the data and to set the window length and corresponding failure parameters.

Therefore, an appropriate option is to use individual subplot results for SPC and expand the number of samples in the SPC window beyond 20. In cases where individual establishments produce on fewer days than the SPC window length, any revised criteria would be applied to the number of lots presented. One disadvantage of this approach is that the statistical power of detecting shifts in microbial rates is reduced in the small producers. In these instances, because the individual contracts between AMS and suppliers indicate the intended amount to be produced, parameters could be developed on a case-by-case basis for contracts with fewer sublots than the new window length.

This option allows all data to be used in assessing SPC and is preferable if the hour-to-hour variability is an essential factor. Because the time needed to move beyond a 20-sample window is relatively short and the time needed to be informed of test results is relatively long, the window should be extended beyond 20 samples and the parameters associated with the plan adjusted accordingly.

Further analysis of AMS data and the statistical properties necessary for SPC are needed to set the window length and corresponding failure parameters. NACMCF will address this area in the second phase of this charge.

For boneless beef, using only one of every five combo bins for SPC reduces the statistical power to detect a loss of process control. The choice of including all combo bin test results or a "skip-lot" approach yields options similar to those in ground beef. Further analysis of boneless beef testing is needed to more definitively inform AMS on whether a more traditional performance-based skip-lot sampling program can be used for verification testing and SPC.

The AMS has been collecting data on microorganisms in these products for years; however, some of the criteria change from year to year. These changes can make drawing comparisons across years problematic. Therefore, the analysis by NACMCF has focused primarily on the most recent data from July 2011 into January 2012. Further analysis of AMS data is needed to identify a more definitive set of options such as revising some of the testing into a more traditional skip-lot program.

The option shown above is not the only one that could be used in the AMS program. AMS should continue the analyses mentioned above and update NACMCF as soon as practical for consideration in a proposed future NACMCF charge.

Conclusions

- The Committee concurs with NRC 2010 findings (17) that application of the same criteria for all product streams (i.e., product cooked with oversight by AMS versus sent to the school in raw form) is not consistent with Codex principle CAC/GL 21-1997 Section 2.3 (6). Furthermore, the Committee concurs that a validated

cook process provides greater control of risk than relying on finished product testing (9, 17).

- Boneless beef and ground beef intended for cooking in a USDA-FSIS-inspected facility using a validated process does not require pathogen testing because cooking will eliminate *E. coli* O157:H7 and *Salmonella*. Microbiological testing of indicator organisms, such as generic *E. coli* and coliforms with ecological niches similar to those of enteric pathogens, are useful to ensure that the process is under control, carcass decontamination is verified, and sanitation is sufficient. *Salmonella* testing for compliance with USDA performance standards provides an additional verification that the process is controlled.
- The AMS 2011 microbiological testing of every lot or subplot but using only select data (skip-lot) for indicator organisms for SPC provides no substantive advantage with regards to product testing. Boneless beef establishments whose tests do not meet certain parameters in the SPC plan are placed into a conditional plan, but neither the testing frequency nor the rate of inclusion in the SPC calculations are increased as standard practice for skip-lot testing (1, 12). Given the difficulties in managing a data subset, including ignoring some collected results, as well as seeing no advantage with skip-lot data analysis, AMS use of all SPC data collected is a reasonable alternative at this time.
- The current N60 sampling scheme for *E. coli* O157:H7 is consistent with the accepted standard for USDA-FSIS sampling for nonintact beef (28) and for commercial production practices (2). Despite the excellent safety record associated with cooking conducted at the schools, the safety associated with products released to schools in raw form is less certain because the final lethality step (reduction in risk) is conducted outside oversight of AMS and FSIS and there exists a remote risk of cross-contamination of other ready-to-eat foods if the pathogen is present in the raw ground beef. Given the low pathogen prevalence in boneless beef and ground beef produced for AMS, even robust sampling plans have limited ability to detect foodborne pathogens. The Committee acknowledges the limitations of sampling but also notes that stringent *E. coli* O157:H7 testing in boneless beef and ground beef provides an extra, but small, level of probability of finding the pathogen. No change in frequency of sampling is recommended at this time for *E. coli* O157:H7 in boneless beef trim intended for grinding and subsequent direct sale to schools in raw form.
- AMS's use of *Salmonella* for product disposition is inconsistent with FSIS use of *Salmonella* as a performance standard. As with *E. coli* O157:H7, epidemiological data revealed no *Salmonella* illnesses linked to ground beef obtained through the Federal Purchase Ground Beef Program or any other source since 1998 and specifically since the inception of HACCP principles in the NSLP. Testing at current levels (N5 for boneless beef or N4 for ground beef) has potential merit in determining supplier eligibility (in line with FSIS *Salmonella* performance standards) as an indicator of other enteric

pathogens and to direct *Salmonella*-positive lots into the product stream that includes validated cooking with AMS oversight of USDA-FSIS-inspected cooking. This approach can serve to limit potential exposure to enteric pathogens that might occur through cross-contamination at the school level.

- The high degree of compliance with the requirement for a food safety plan based on HACCP principles in the NSLP and strong food safety practices while cooking raw ground beef suggest that there is no apparent scientific justification for continuing the increased testing schedule (both whole-lot and subplot testing) for product disposition of ground beef. Thus, the extra N8 sampling schedule implemented in TRS 2010 was not necessary to ensure safe food. It was concluded that eliminating N8 whole-lot cleanup-to-cleanup testing while retaining N4 1-h lot (or 10,000-lb [4,540-kg] maximum) testing composited into one analytical unit per hour (or 10,000 lb [4,540 kg] maximum) provides a scientifically valid sampling plan that is more balanced for logistics and cost of implementation.
- The safety of ground beef products served in the NSLP, as with all foods, relies on a multifactor and integrated food safety system, including controls during production, processing, distribution, storage, and any necessary lethality steps. Resources spent on enforcing HACCP controls to prevent and reduce contamination in the raw commodity result in more reliable outcomes of food safety than additional finished product testing. Microbiological sampling is a useful tool in verifying process control but is neither practical nor sufficient to provide 100% guarantee of food safety.

RECOMMENDATIONS FOR AMS 2012 TECHNICAL REQUIREMENTS SCHEDULE

Note: These recommendations and further projections will be applicable until AMS seeks further advice from NACMCF.

- Maintain high standards of supplier control, HACCP implementation, carcass testing, traceability, etc., as in current program. Each plant is subjected to verification audits conducted during production activities that demonstrate their adherence to the documented program.
- With the exception of eliminating *S. aureus* testing, no changes to testing of indicator organism types are recommended at this time.
- For boneless beef trim and ground beef intended for further processing in a USDA-FSIS-inspected facility using a validated cooking process with AMS oversight, testing for *E. coli* O157:H7 or *Salmonella* for disposition is unnecessary and should be discontinued.
- For product to be delivered to schools raw, boneless beef trim or ground beef lots that exceed any of the critical limits for *E. coli* O157:H7, *Salmonella*, or indicator organisms designated in Appendix B of the TRS-BB-2010 (22) and TRS-GB-2010 (21) will be directed to a product line for cooking at a USDA-FSIS-inspected facility.

- For product to be delivered to schools raw, although the N60 sampling plan is more stringent than would be recommended when considering the documented compliance with food safety practices in the NSLP, AMS should continue N60 sampling for *E. coli* O157:H7 for boneless beef trim for two reasons. First, N60 testing is the accepted standard for USDA-FSIS sampling and commercial practices for nonintact beef. Second, diverting positive lots for cooking in USDA-FSIS-inspected facilities using a validated cooking process with AMS oversight will remove these lots from the product stream delivered to the school system as raw and can serve to further reduce the risk of cross-contamination with ready-to-eat foods.
- For ground beef product destined for schools in raw form or for cooking in facilities outside AMS oversight, discontinue N8 whole-lot testing but retain N4 for 1-h sublots (maximum of 10,000 lb [4,540 kg]; N4 composited into one analytical unit). Each subplot found to be culture positive for *E. coli* O157:H7 plus the “shoulder” sublots on either side of the positive subplot will be diverted for cooking at a USDA-FSIS-inspected facility using a validated cooking process with AMS oversight for use in the AMS program.
- Continued testing of *Salmonella* (N5 for boneless beef per 2,000-lb [908-kg] combo bin; N4 for ground beef, 1-h subplot, 10,000 lb [4,540 kg] maximum; 25-g composite analytical unit) should be used to verify that intervention processes are controlled and as a factor to determine supplier eligibility. *Salmonella*-positive combo bins and sublots will be diverted for cooking at a USDA-FSIS-inspected facility using a validated cooking process with AMS oversight for use in the AMS program to reduce the risk of cross-contamination with ready-to-eat foods at the school level.
- Use of all data collected for SPC is suitable. AMS should continue its analyses of the options and factors mentioned and provide an updated report for 2013 with recommendations of scientifically supported implementations of a performance-based skip-lot sampling program and SPC practices as warranted.
- Regardless of sampling program, AMS should continue on-going program reviews in consultation with FSIS and ARS to determine if any requirements need to be strengthened in supplier eligibility, processing, etc., including use of additional or alternative intervention strategies.

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APPENDIX

Definitions

1. *Alternative screening method/procedure*: Any method, other than recognized reference method, that would provide comparable results and therefore is used to make decisions about the sample.
2. *Boneless beef*: Beef manufacturing trimmings.
3. *Confidence statements*: Confidence applies to an event after the event has occurred. For example, suppose a lot has been sampled and rejected because a pathogen has been detected in the sampled units. For that rejected lot and based on the sampling plan used, one can state with 95% confidence that, for example, 0.5% or more of the sample units in the entire lot will test positive for that pathogen. Note: This is an example of a confidence statement, not a probability statement, because the lot is known to have been rejected.
4. *Contractor*: Finished product processor.
5. *Finished product*: Final ground beef product.
6. *Independent certifying organization*: A body that organizes validation studies based on microbiology validation guidelines published by AOAC (7). These bodies include AOAC (Official Methods of Analysis and Performance Tested Method programs), AFNOR, MicroVal, and NordVal.
7. *Prevalence*: Proportion of samples or lots containing hazard.

8. *Probability statements*: Probability applies to an event before the event occurs. For example, suppose a lot has a 1% prevalence of a certain pathogen. It can be shown that there is a sampling plan that will detect, with 95% probability, the presence of that pathogen in that lot. Note: This is an example of a probability statement because the event of sampling and testing has not yet occurred. Frequently in practice, 95% probability is replaced with 95% confidence which technically is incorrect (see *confidence statements* above).
9. *Process control or capability*: As per TRS-GB-2010 (21), process capability assessments are conducted on data results from each lot for microbial requirements. A process assessment involves sampling and testing of 20 consecutive lots (which always includes the last recorded result). Information from each lot will be evaluated with information from the preceding 19 lots. This has often been referred to as a “rolling 20.” This assessment takes into account process variations that may be attributed to product, management, sources, and time.
10. *Reference method*: This refers primarily to cultural methods from the FSIS MLG suitable for the analysis of meat, poultry, and egg products. Methods published by the FDA and ISO may be appropriate on a case-by-case basis.
11. *Robust validation study*: A validation study which measures method performance against the appropriate FSIS reference method. The full data set and validation report would be subject to evaluation by FSIS. FSIS would use test kit validation guidelines to evaluate the study design and results (30).
12. *Statistical process control (SPC)*: As per TRS-GB-2010 (21), SPC is the primary analysis tool of quality improvement. The objective of any quality improvement strategy is to identify and reduce the amount of variation. SPC analyzes the variation in a process and is the applied science that assists suppliers to collect, organize, and interpret microbial and fat test results on processing of ground beef destined for USDA.
13. *Supplier*: Boneless beef manufacturer.