

Standardization Division Livestock and Seed Program 1400 Independence Avenue, SW. Room 2607-S, STOP 0254 Washington, DC 20250-0254

# **Instrument Grading Systems for Ovine Carcasses**

Performance Requirements for Instrument Quality Grade Evaluation Demonstration of Accuracy and Precision

### BACKGROUND

The Department of Agriculture (USDA), Agricultural Marketing Service (AMS), Livestock and Seed (LS) Program will accept ovine carcass quality grade measurements made by approved instruments. The LS Program will approve instrument systems that meet specific performance requirements for accuracy, and precision in the prediction of quality grade of carcasses. Approved instruments may be used in conjunction with Grading and Verification Division MGC Instruction 512 "Alternative Methods for Evaluating Ovine Spool/Break Joints for Carcass Classification." The performance requirements outlined in this document were established after consultation with an Industry Working Group that was convened by the LS Program and the American Sheep Industry Association (ASI). The Industry Working Group was comprised of representatives of USDA, ASI, packing companies, producers, instrument manufacturers, and academia.

### PURPOSE

The purpose of this document is to provide a performance standard to determine if instrument systems can objectively predict, accurately and precisely, a quality grade prior to carcass chilling. An instrument must be tested and must meet the following requirements to gain approval from the LS Program. The approval process consists of a demonstration of the accuracy and precision of quality grade prediction at line speeds.

### **REFERENCE DOCUMENTS**

Alternative Methods for Evaluating Ovine Spool/Break Joints for Carcass Classification. Grading and Verification Division, MGC Instruction 512, July 23, 2002.

Instrument Grading Systems for Ovine Carcasses: Performance Requirements for Instrument Cutability Evaluation (PRICE), October, 2011.

Standard Specification for Developing and Validating Prediction Equation(s) or Model(s) Used in Connection with Livestock, Meat, and Poultry Evaluation Device(s) or System(s) to Determine Value. ASTM International Standard F 2340-05.

Standard Terminology for Livestock, Meat, and Poultry Evaluation Systems. ASTM International Standard F 2463-06.

United States Standards for Grades of Lamb, Yearling Mutton, and Mutton Carcasses. United States Department of Agriculture, July 6, 1992.

# METHODOLOGY

#### Carcass Imaging and Selection

An instrument system must be tested during four separate seasons to ensure variation due to lamb production seasonality is considered. Trial dates and lamb sources are to be determined by AMS. During each of the four trials, a target of 150 carcasses shall be included to adequately represent the U.S. lamb population (i.e., each instrument presented for approval must be tested on 600 or more carcasses). Carcass selection is to be based on the moderate-strong relationship between final quality grade and yield grade (Pearson's correlation coefficient 0.4 to 0.6). Carcass weights should be reasonably distributed above and below an average dressed carcass weight of 69.5 pounds (average dressed carcass weight for the years 2000-2009). If a company-specific user of an instrument system seeks approval for use only within their organization, the instrument system must also be tested as specified above.

	Number for On-line
Yield	Grading per Trial
Yield Grade 1	22
Yield Grade 2	36
Yield Grade 3	43
Yield Grade 4	27
Yield Grade 5	22
Total	150

### Table 1. Minimum Number of Carcasses for Instrument Assessment

Carcasses must be presented for image capture and analysis at a continuous normal operating speed. The Yield Grade matrix shown in Table 1 will serve as the template in guiding carcass selection. Following carcass evaluation by the instrument, an AMS representative will visually estimate USDA Yield Grade and another AMS representative will select carcasses to be included in the study. Selected carcasses will be placed in a holding cooler to obtain a 24-hour chill. Carcasses will then be segregated onto a stationary rail for the determination of USDA quality grade as described below.

### Establishing the Official USDA Quality Grade

In order to validate the accuracy and precision of an instrument system, an official panel quality grade score must be established for each carcass. Quality grade score must be evaluated by a panel of two officials designated by AMS after adequate carcass chilling or otherwise evaluated by a method approved by AMS. The official panel will independently evaluate the quality grade scores in accordance with the United States Standards for Grades of Lamb, Yearling Mutton, and Mutton Carcasses (July 1992). Quality grade score shall be recorded to the nearest 10 quality grade score units. The quality grade score will be numerically coded as follows:

Quality Grade	Score
Prime	400
Choice	300
Good	200
Utility	100
Cull	0

#### Table 2. Quality Grade Coding Score

AMS will compute the average official quality grade. Since carcasses were selected by visually appraised yield grade, the data will be sorted by a cutability measure (Performance Requirements for Instrument Cutability Evaluation, October 2011), season and lot number and then every third carcass will be assigned to the validation data set with the other two assigned to the calibration data set. AMS will provide

average official quality grade score, all carcass data, the percent OCC yield, hot carcass weight and chilled carcass weight to the technology provider for the carcasses assigned to the calibration data set. The technology provider may use the calibration data to develop or refine their quality grade prediction equation.

# Submission of Predicted Quality Grade and Prediction Equation

At the completion of the four trials, the technology provider will submit the instrument predicted quality grades to AMS for comparison with the official quality grades of the validation data set. AMS will then compute the necessary statistics to determine if the instrument system meets the requirements in the Performance Requirements section below. The technology provider will provide AMS with a copy of the prediction equation used as well as the values for each variable in the prediction equation for each of the predicted quality grades, which AMS will use to validate the information collected and outputs computed.

# Exclusion of Images Captured and Data Collected

In order for the test to provide the best results possible, AMS will review all data and images to determine if the data and images from the selected carcasses were accurately obtained. Technology providers must submit to AMS the original image and the processed display screen image or thumbnail for each carcass in the test so that images can be reviewed to determine if proper image capture occurred.

# PERFORMANCE REQUIREMENTS

Scope

Approval will be granted in accordance with the following performance requirements to an instrument system that predicts a quality grade accurately and precisely using instruments and devices that utilize a validated prediction equation. The scope of an instrument's approval is determined by AMS and will be based on the intended use of the instrument system. The scope will be set forth in the final approval.

**On-line Measurement of Accuracy and Precision Performance Specifications** 

- Average residual =  $0 \pm 10$  quality grade units where the residual is the difference between the instrument quality grade and the average official quality grade;
- The standard deviation of the residuals (rSD) from the average official quality grade ≤ 35 quality grade units;
- The instrument quality grade agreement rate with the quality grade of one or both panel members  $\geq 85\%$ ; and,
- The prediction equation would be deemed valid if the root mean square error for validation is within 20 % of the root mean square error for calibration (see ASTM International Standard F 2340). The root mean square error for validation is defined by square root of the sum of squared residuals divided by  $n_y$  where  $n_y$  is the sample size for the validation data set. The root mean square error for calibration is defined by the square root of the sum of squared residuals divided by  $n_c (k + 1)$  where  $n_c$  is the sample size for the calibration data set, and k is the number of explanatory variables in the prediction equation.

# ESTABLISHMENT IMPLEMENTATION APPROVAL PROCESS

Procedures for the implementation and verification of operational accuracy will be established and approved on a plant-by-plant basis once the instrument has met the performance requirements above. For the minimum criteria that must be addressed, please review the LS Program document titled *Implementation and Verification of Operational Procedures*.

This standard is subject to revision at any time by the LS Program.

Requests for approval shall be submitted to:

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