

MEO

**Procedures for Approval and Use of Vision Based Instrument Systems  
for Beef Carcass Yield Grade Measurement  
Livestock and Seed Program, Agricultural Marketing Service  
March 2005**

**BACKGROUND:**

The Department of Agriculture (USDA), Agricultural Marketing Service (AMS), Livestock and Seed (LS) Program will accept beef carcass yield grade measurements made by approved instruments. To be approved by the LS Program for such a purpose, the instrument must meet certain performance requirements for accuracy and repeatability in the prediction of the yield grade of carcasses. 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 National Cattlemen's Beef Association (NCBA). The Industry Working Group was comprised of representatives of USDA, NCBA, packing companies, producers, instrument manufacturers, and academia.

The purpose of this document is to provide the meat industry with a blueprint for developing the documentation that is required to gain instrument approval from the LS Program. The process consists of three phases:

- Phase I Demonstration of the accuracy and repeatability of yield grade prediction on stationary beef carcasses.
- Phase II Demonstration of the accuracy of yield grade prediction at line speeds.
- Phase III Daily in-plant verification of the approved instrument to validate that the instrument is correctly calibrated and that the correct data is presented to the USDA grader.

**PERFORMANCE REQUIREMENTS:**

Phase I and II data shall be entered into the MS Excel workbook available at <http://www.ams.usda.gov/lsg/stand/beefyieldgradeinstrument.xls>. The workbook contains the formulas to establish if all Phase I and II requirements have been met. Instruments must meet all the performance criteria outlined in Phase I and II to receive approval. In order to ensure the integrity of the data, the AMS representatives will be provided the data from the vision instrument prior to the information from the expert panel evaluation being entered into the database. This will constitute the official data from the instrument and will be used to validate the findings of the test.

In order to validate the accuracy of an instrument, an *actual expert calculated yield grade* must be established for each carcass that is measured. The yield grade factors must be evaluated by a panel of three officials from the Standardization and Meat Grading branches of AMS or evaluated by a method approved by the LS Program. The panel of three officials will evaluate:

- *Adjusted Preliminary Yield Grade* based on the fat cover of the entire carcass.
- *Percent Kidney, Pelvic, and Heart Fat* estimated as a percent of the hot carcass weight (pounds) or, if removed, the actual percent.
- *Ribeye Area, square inches*, determined by grid, tracing and planimeter, or by an instrument approved by the LS Program for ribeye area measurements. The panel will evaluate the same side evaluated by the instrument being tested.
- The *actual expert calculated yield grade* shall be a consensus yield grade calculated to the nearest 0.1 yield grade unit using the USDA "short-cut method" (Appendix A) or the official Yield Grade equation:

$$\begin{aligned} \text{Yield Grade} = & 2.50 + (2.50 \times \text{adjusted fat thickness, inches}) \\ & + (0.20 \times \text{percent kidney, pelvic, and heart fat}) \\ & + (0.0038 \times \text{hot carcass weight, pounds}) \\ & - (0.32 \times \text{area of ribeye, square inches}) \end{aligned}$$

### **Phase I: Stationary measurements**

One of two acceptable methods may be used for collecting images (data) from stationary carcasses for Phase I. However, for either method, a minimum of 200 sides shall each be measured three (3) times to provide a total of at least 600 observations to measure performance. The sample population shall adequately represent the full range of yield grades. At least 20% of the sides must be left carcass sides and at least 20% of the sides must be right carcass sides. The two methods are:

Triple Trigger: Place the camera head unit over the 12th-13th rib interface of one side of each carcass, and obtain three sequential but separate images without moving the camera head unit.

Triple Placement: Place the camera head unit over the 12th-13th rib interface on one side of each carcass and obtain one image; remove the camera head unit; return the camera head unit to the ribeye interface and obtain a second image; remove the camera head unit again; return the camera head unit to the ribeye interface, and obtain a third image.

NOTE: The Triple Trigger method shall be used for Phase I testing unless instrument restrictions prevent its use. In such cases, the Triple Placement method shall be used.

All three images will be used for the evaluation of repeatability and accuracy. Accuracy will be evaluated by comparing (correlation and regression) the yield grade output to the *actual expert calculated yield grade*.

Performance requirements for Phase I:

Stationary Accuracy  $R^2 = 0.90$  or greater; 95% of predicted yield grade observations within 0.5 yield grade units of the *actual expert calculated yield grade*, and the residual standard deviation (RSD) shall not exceed 0.25 yield grade units.

Stationary Repeatability 95% of the carcasses shall have all three of the predicted yield grade observations within 0.1 yield grade unit of the mean predicted yield grade for that carcass.

### **Phase II: Operational measurements**

Carcasses (n = 200 minimum) must be presented for image capture and analysis under normal beef carcass grading conditions (i.e., freshly-ribbed carcasses moving at a minimum chain speed of 300 head/hour). Following collection of images, carcasses should be placed on a stationary rail for determination of *actual expert calculated yield grade* as described above. Accuracy will be evaluated by comparing (correlation and regression) the yield grade observation to the *actual expert calculated yield grade*.

Performance requirements for Phase II:

Operational Accuracy  $R^2 = 0.90$  or greater; 95% of predicted yield grade observations within 0.5 yield grade units of the *actual expert calculated yield grade*, and the residual standard deviation (RSD) shall not exceed 0.25 yield grade units.

### **Phase III: Operational Process Verification**

Procedures for verification of operational accuracy of instruments will be established on a "plant by plant" or "company by company" basis by the applicant and approved by the LS Program. An approved, verifiable process must be in place for a plant to use the instrument for yield grade determination. Criteria that must be addressed in the Operational Process Verification Program include:

- Instrument set-up and calibration routine.
- Verification of system calibration before instrument use.
- Record of validations.
- Training/control of instrument operators.
- Operator audits.
- Linking of hot carcass weight, carcass image data, and presentation to grader for review and/or acceptance of image acquisition, grade eligibility, and grade determination.
- Grade identification/application procedures.
- Submission and approval of any system changes.

Approved  
USDA, AMS, LS, STDZ  
March 2005  
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LS may change the performance approval criteria when technology improves.

Requests for approval shall be submitted to:

Chief, Standardization Branch  
USDA, AMS, LS  
Room 2607 South Building, Stop 0254  
1400 Independence Avenue, S.W.  
Washington, DC 20250-0254

Phone: (202)-720-4486  
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Approved:



Martin E. O'Connor, Chief  
Standardization Branch

## APPENDIX A: OFFICIAL USDA SHORT-CUT METHOD OF DETERMINING YIELD GRADE

- I. Determine a **PRELIMINARY YIELD GRADE (PYG)** to the nearest tenth from the following schedule:

<u>Adjusted Fat Thickness</u>	<u>Preliminary Yield Grade</u>
.0 inch	2.0
.2	2.5
.4	3.0
.6	3.5
.8	4.0
1.0	4.5
1.2	5.0
1.4	5.5

The fat thickness is a single measurement of fat over the ribeye three-fourths of the length of the ribeye from its chine bone end. (Each 0.1 of a PYG equals 0.04 inch.)

The PYG may be adjusted, either upward or downward, as necessary, to reflect unusual amounts of fat on other parts of the carcass.

- II. Determine the **FINAL YIELD GRADE** by adjusting the PYG, as necessary, for variations in kidney, pelvic, and heart fat from 3.5 percent and for variations in area of ribeye from the weight-area of ribeye schedule as shown. Such adjustments are rounded to the nearest tenth of a yield grade.

A. Rate of adjustment for area of ribeye in relation to weight:

For each square inch more than the area indicated in the weight-area of ribeye schedule, subtract .3 of a grade from the PYG yield grade.

For each square inch less than the area indicated in the weight-area of ribeye schedule, add .3 of a grade to the PYG. To determine the rate of adjustment for area of ribeye when the deviation from that required in the schedule is a fraction of an inch(es), the deviation is multiplied by .3, rounded to the nearest tenth, and the proper adjustment (plus or minus) is made to the preliminary yield grade.

B. Rate of adjustment for percent kidney, pelvic, and heart fat:

For each .5 percent of kidney, pelvic, and heart (KPH) fat more than 3.5 percent, add .1 of a grade to the PYG. For each .5 percent of KPH fat less than 3.5 percent, subtract .1 of a grade

from the PYG. The quantity of KPH fat is estimated as a percent of the hot carcass weight and is normally estimated in .5 percent increments.

NOTE: Fractional parts of the final yield grade are dropped in normal grading procedures. For example, a yield grade calculated as 3.9 is a 3. However, for carcass evaluation and other purposes, this method allows the final yield grade to be determined to tenths. If more precise calculations are needed, it is recommended that the yield grade equation be used.

**WEIGHT--AREA OF RIBEYE SCHEDULE**

Hot Carcass Weight (lbs.)	Area of Ribeye (sq. in.)	Hot Carcass Weight (lbs.)	Area of Ribeye (sq. in.)	Hot Carcass Weight (lbs.)	Area of Ribeye (sq. in.)
500	9.8	700	12.2	900	14.6
525	10.1	725	12.5	925	14.9
550	10.4	750	12.8	950	15.2
575	10.7	775	13.1	975	15.5
600	11.0	800	13.4	1000	15.8
625	11.3	825	13.7	1025	16.1
650	11.6	850	14.0	1050	16.4
675	11.9	875	14.3	1075	16.7

Guide to determine required ribeye area for weights of carcasses between the 25 pound gradations:

<u>Hot Carcass Weight</u>	<u>Area of Ribeye</u>
600-608# (9#)	11.0 sq. in.
609-616# (8#)	11.1 sq. in.
617-624# (8#)	11.2 sq. in.
625-633# (9#)	11.3 sq. in.

The 9,8,8 pound "cycle" is repeated for each 25 pounds.