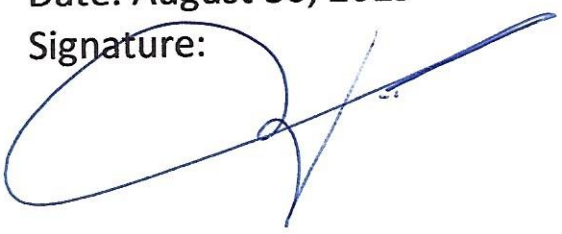
Report on a modification trial of the Mechanical Beef Classification System currently in use in Ireland:

the VBS2000.

Place: Slaney Foods, Bunclody
Period: May 2018 - March 2019

Ing. P.A.C.M. (Piet) van de Lindeloof
Classification expert; the Netherlands

Date: August 30, 2019
Signature:



Contents

1. Summary

Mechanical classification of Beef Carcasses is operating in Ireland since 2003 / 04 and is operating in full compliance with EU regulations. However a combination of technical circumstances, including cameras and operating systems becoming obsolete, the evolution of new technology, coupled with a desire to examine opportunities to improve performance of the machines lead to a possible modification of the current technologies being considered by the industry.

To validate this new technology a trial was organised at Slaney Foods in Bunclody. In Summer 2018, classification results from 2,431 carcasses were used to calibrate the new technology. In February 2019, a further 2,100 carcasses were used to validate this new technology.

Mr Piet van de Lindeloof, an independent classification expert from the Netherlands, was employed to oversee the trial.

The following is a summary of the results of the trial:

- For the purpose of the trial more than sufficient numbers of carcasses, representative of the Irish cattle population, are present in the total sample selected and in the extracted sub-samples.
- The accuracy results for the modified machine are at levels that exceed what is required in EU legislation to authorise such grading machines.
- The accuracy and bias results for the modified machine are at levels greater than those for the classification machine currently in use although the current machine also performed at very high levels.
- Future application of the modernised equipment will result in a better performance of classification and will be more future-proof due to the use of modern techniques and equipment.

2. Introduction

Classification is a prediction of the quantity of meat and fat on a carcass based on uniform criteria laid down in European legislation. It is obligatory to apply classification across the EU in all slaughterhouses killing more than 150 bovines per week. Beef classification can be applied manually by a licensed classifier or by approved automated grading techniques.

In 2018 it was decided to organise a modification trial for the classification machine VBS 2000 which is in use since 2004. The reason for this was that the current machines are equipped with analogue cameras and a fluorescent lighting system that are becoming obsolete. There is a huge risk that in the future these components will be no longer available. Therefore replacement of analogue by digital cameras and the introduction of LED lights appear to be

necessary in the near future. Also the modification trial was required to (1) ensure compliance with EU regulations and (2) promote greater stakeholder confidence by adopting the modified technology .

The Ministry appointed a neutral classification expert, Mr. P. van de Lindeloof*, to oversee this trial with special attention to the following:

- The modification trial is carried out in line with the relevant legislation
- The Population in the trial represents the Irish herd
- Identifying the best possible performance of the modified grading machine for future use
- Evaluating the new system at the end of the trial
- Drafting a final report.

*Information regarding the classification expert you will find in Annex III.

3. History and authorisation of mechanical beef classification in Ireland

In the beginning of this century the beef sector became interested in automated grading. Therefore DG AGRI of the European Commission developed an authorisation system for this equipment which was published in Regulation (EC) No 1215/2003. Authorisation can be granted by the Member State after organising a test with at least 600 carcasses representing the herd population in the Member State concerned. Further details about this test can be found in Annex II of Regulation (EC) No 1249/2008 and Annex IV of Regulation (EU) 2017/1182.

The authorisation criteria were set up with the idea that the performance of automated grading equipment should be at least as good as the average European human classifier. During the authorisation test the classification results of the machine are compared with the median score of the jury panel composed of 5 experienced classifiers. For this type of comparison a scoring system was developed and set in EU legislation (Table 1).

Table I Point system

	Conformation	Fat cover
No difference	10	10
Difference of one subclass up or down	6	9
Difference of two subclasses up or down	-9	0
Difference of three subclasses up or down	-27	-13
Difference of more than three subclasses up or down	-48	-30

Following developmental work in 2002, an approval (authorisation) test was organised in 2004 in Midleton where three machines were tested and subsequently authorised.

After this approval test the Irish authorities and the beef industry decided to apply automated beef grading in Ireland and the German machine VBS2000 was chosen and installed in 23 slaughterhouses.
The VBS2000 uses visual image analysis technology. The mechanical classification machine analyses a visual image of the carcase captured by a camera. It then applies specially constructed authorised equations to convert this image into a classification result.

Automated grading equipment is also approved in several other Member States (Denmark, Spain, France, UK).

4. Current Legislation

Beef classification is underpinned by legislation as follows:

- Regulation (EU) No 1308/2013 of the European Parliament and of the Council of 17-12-2013 establishing a common organisation of the markets in agricultural products.
- Commission delegated regulation(EU) 2017/1182 of 20 April 2017;
  supplementing Regulation (EU) No 1308/2013 of the European Parliament and of the Council as regards the Union scales for the classification of beef, pig and sheep carcasses and as regards the reporting of market prices of certain categories of carcasses and live animals; and
- Commission Implementing Regulation (EU) 2017/1184 of 20 April 2017
  laying down rules for the application of Regulation (EU) No 1308/2013 of the European Parliament and of the Council as regards the Union scales for the classification of beef, pig and sheep carcasses and as regards the reporting of market prices of certain categories of carcasses and live animals.

This trial was organised to show that the modifications being applied are in compliance with the current legislation and will result in at least the same level of accuracy as the minimum required for an authorisation test. If that is the case the modifications can be approved. Article 10(7) of Regulation (EU) 2017/1182 states:
'Modifications of the technical specifications of an authorised beef or sheep automated grading method shall be approved by the competent authorities subject to proof that such modifications result in a level of accuracy that at least fulfils the minimum requirements for an authorisation test. Member States shall inform the Commission of any such modifications for which they have given their approval'.

To approve such modifications to a mechanical classification system a certification test is obligatory as indicated in Article 10(1-6) and Annex IV of Regulation (EU) 2017/1182. For such a certification test the Member State is free to choose the test methodology.

5. Modification Trial - Procedures

The trial was carried out at Slaney Foods in Bunclody. In this slaughterhouse two VBS 2000 machines were used:

- The existing classification machine currently authorised for classification.
- A second classification machine especially installed for this trial using modified technology - a new digital camera and LED lights.

While in effect this was a modification trial, a procedure in line with the requirements laid down in the EU legislation to authorise an automated grading device in a Member State was followed.

For such a modification the EU legislation obliges the Member State authorities to prove that such modifications result in a level of accuracy that at least fulfils the minimum requirements for an authorisation test.

Procedure and main conditions applied by the Irish authorities:

a) In the summer of 2018, 2,431 carcasses were classified by three Irish classification experts in order to provide the machine manufacturer (E+V) with sufficient information to calibrate the modified machine (new developed digital camera and LED lights)

b) The modified technology was subsequently trialled during a validation phase ending in February 2019 on 2,100 carcasses.

c) The grades of these 2,100 carcasses were calculated by the existing classification machine using the existing equations from the 2002 trial (the equations that continue in use in the current machine up to the present day). The results are presented in Table 3

d) The grades from the modified classification machine were also calculated using the existing equations from the 2002 trial. The results are presented in Table 4

e) With a view to identifying the optimum suite of equations that would give the greatest accuracy using the modified technology, E+V examined the use of the current 2002 equations and also equations from a second authorisation trial conducted in 2014. A mix of equations provided the optimum result. This resulted in two of the 2002 equations being substituted with two equations from the authorisation trial held in 2014 (i.e. the equations responsible for determining conformation in categories D and E). The results are presented in Table 5

f) In addition to the above, a sub sample of 989 of the 2,100 carcasses was selected to represent the national herd. (See section 6) and the above conditions were applied to this sub sample also.

6. Composition of Irish herd versus sample

The matrix used in the trial was based on the slaughter profile of the Irish herd in 2017.

Table 2: Numbers slaughtered at DAFM approved Meat Plants in 2017

Young bulls (A)	Old bulls (B)	Steer (C)	Cow (D)	Heifer (E)	Cat V	Cat Z	Totals
195,942	28,203	681,152	374,013	460,285	5,930	1,528	1,747,053
11.22%	1.61%	38.99%	21.41%	26.35%	0.34%	0.09%	100%

Percentages excluding Veal in the sample

11.26%	1.62%	39.16%	21.50%	26.46%			100%

Representative number classified in sample of 989

113	4	392	215	265			989

In terms of category, all categories apart from category B are sufficiently represented in the sample of 989 carcasses

Annex I contains information regarding the overall matrix in whole classes.

Conclusion regarding the matrix
For the purpose of this trial I conclude that more than sufficient numbers are represented in the total sample and in the extracted sub-sample of 989 carcasses

7. Performance of the modified grading machine

The grading machines were tested by comparing the classification results with a team of three Irish classification experts. These results were subsequently analysed taking 2 samples:

a. Comparison with the sample population of 2,100 carcasses

b. Comparison with a sub sample of 989 carcasses out of the 2,100 carcases corresponding with the Irish herd.

The results of these measurements and the performance of the modified machine are as follows:

- Performance of the existing classification machine using the existing (2002) equations – Table 3
- Performance of the modified technology using the existing (2002) equations – Table 4
- Performance of the modified technology using the optimum suite of equations (2002 and 2014) – Table 5

Table 3: Results using the existing system and 2002 equations:

		Conformation			Fat cover		
	Number	Points/%	Bias	Slope	Points/%	Bias	Slope
Total sample	2100	84.1	0.17	+0.97	85.7	-0.14	1.11
		Conformation			Fat cover		
Representative Sample of 989	Number	Points/%	Bias	Slope	Points/%	Bias	Slope
Total	989	82.5	0.13	0.96	82.2	-0.25	1.15

Table 4: Results using the modified technology and 2002 equations:

		Conformation			Fat cover		
	Number	Points/%	Bias	Slope	Points/%	Bias	Slope
Total sample	2100	85.2	0.01	1.00	93.3	-0.05	0.89
		Conformation			Fat cover		
Representative Sample of 989	Number	Points/%	Bias	Slope	Points/%	Bias	Slope
Total	989	87.1	0.04	0.99	92.9	-0.04	0.88

Table 5: Results using the modified technology and an optimum suite of equations:

		Conformation			Fat cover		
	Number	Points/%	Bias	Slope	Points/%	Bias	Slope
Total sample	2100	90.3	0.01	0.99	93.3	-0.05	0.89
		Conformation			Fat cover		
Representative Sample of 989	Number	Points/%	Bias	Slope	Points/%	Bias	Slope
Total	989	89.4	0.03	0.99	92.9	-0.04	0.88

8. Comparison of Old vs New Machines

For a modification trial, as set out in section 4, it is not necessary to compare the performance of the modified machine with the existing classification system. However, for transparency, the 3 sets of results are presented in this report in the above Tables 3, 4 and 5.

It is clear that the new modified technology (Digital camera and LED lights) improves the accuracy of the classification system. This can be seen from the higher accuracy % and lower bias associated with the modified technology when compared with the original technology (analogue camera and fluorescent lights) – See Table 4 versus Table 3 when both machines are using the 2002 equations.

But when the modified technology (new Digital camera and LED lights) is used with a combination of equations from 2002 and 2014, as described in section 5 (e) above, the accuracy is even higher (See Table 5 versus Table 4). This combination was used for conformation only.

Annex II provides more information regarding the results of the comparison between the old and the new machine.

Results In summary of the performance of the 2 machines (see Annex for this detail):

1. The modified machine has a higher number of instances where the machine and the panel of Irish classification officers had the same grade
2. Using the modified machine, the number of differences of '1 subclass' is reduced i.e. the number of times when the machine and the panel of Irish classification officers differed by 1 sub class
3. Using the modified machine, the number of differences of '2 subclasses' is reduced i.e. the number of times when the machine and the panel of Irish classification officers differed by 2 sub classes
4. The Bias of the modified machine is closer to the optimum figure of Zero.

Conclusions:

These results are beyond what is required in the EU legislation to authorise such modifications and moreover these results are better than previous trials.

The bias in both samples (the total population and sample of 989) is almost zero which means that the average classification result is exactly in line with the results of the Irish experts.

Application of the modernised equipment results in a better, more robust and reliable performance of classification

9. Independent Assessment of Classification

While supervising the trial throughout its operation, at the end of the trial the appointed Dutch expert classified a number of carcasses in Slaney in the same way as the Irish experts carried out the trial. The accuracy and the bias of the modified machine determined during this 2 day period is consistent with the results obtained by the Irish Classification officers.

10. Final conclusion

As a technical expert I am confirming that this trial significantly exceeds what is required for a test where classification equipment is being modified rather than being authorised for the first time.

I can confirm that the trial results show that the modified machine delivers a performance far beyond the legal requirements and compared to earlier trials shows an improvement in accuracy.

It is clear from the results that the highest accuracy and optimum bias is obtained when the modified machine (Digital camera and LED lights) is used with a combination of equations from the 2002 and 2014 trials (The combination of equations was only used for conformation – not for fat).

The existing suite of equations from 2002 also performed very robustly and show results beyond legal requirements.

In my professional opinion this trial satisfies all legislative requirements and I can confirm that the Irish authorities can proceed to authorise the use of the modified technology trialled.

Annex I Information regarding matrix carcass population

Category	Conform.	Number Fat class 1	2	3	4	5	TOTAL	% 1	2	3	4	5	TOTAL
	S												
A	E												
Young bulls	U		3	19	10		32		2,65%	16,81%	8,85%		28,32%
	R	1	1	14	8		24	0,88%	0,88%	12,39%	7,08%		21,24%
	O		14	38	4		56		12,39%	33,63%	3,54%		49,56%
	P			1			1			0,88%			0,88%
	Total	**1**	**18**	**72**	**22**		**113**	**0,88%**	**15,93%**	**63,72%**	**19,47%**		**100,00%**
	S												
B	E		1				1		25,00%				25,00%
Bulls	U		2				2		50,00%				50,00%
	R		1				1		25,00%				25,00%
	O												
	P												
	Total		**4**				**4**		**100,00%**				**100,00%**
	S												
C	E												
Steers	U	1	7	15			23	0,26%	1,79%	3,83%			5,87%
	R	2	24	97	25		148	0,51%	6,12%	24,74%	6,38%		37,76%
	O	1	11	112	79		203	0,26%	2,81%	28,57%	20,15%		51,79%
	P		3	14	1		18		0,77%	3,57%	0,26%		4,59%
	Total	**4**	**45**	**238**	**105**		**392**	**1,02%**	**11,48%**	**60,71%**	**26,79%**		**100,00%**
	S												
D	E												
Cows	U			1	1		2			0,47%	0,47%		0,93%
	R		2	7	6		15		0,93%	3,26%	2,79%		6,98%
	O			19	35	5	59			8,84%	16,28%	2,33%	27,44%
	P	3	15	70	50	1	139	1,40%	6,98%	32,56%	23,26%	0,47%	64,65%
	Total	**3**	**17**	**97**	**92**	**6**	**215**	**1,40%**	**7,91%**	**45,12%**	**42,79%**	**2,79%**	**100,00%**
	S												
E	E												
Heifers	U		6	13	5		24		2,26%	4,91%	1,89%		9,06%
	R		6	52	58	2	118		2,26%	19,62%	21,89%	0,75%	44,53%
	O	1	5	44	65	2	117	0,38%	1,89%	16,60%	24,53%	0,75%	44,15%
	P			2	4		6			0,75%	1,51%		2,26%
	Total	**1**	**17**	**111**	**132**	**4**	**265**	**0,38%**	**6,42%**	**41,89%**	**49,81%**	**1,51%**	**100,00%**

Annex II: Overview classification results comparison old versus new machine (2,100 carcasses)

Old machine 2002 Eq's

Conf

	Points	No. carc.	Score	% score
no difference	10	1331	13310	
1 s/c difference	6	752	4512	
2 s/c difference	-9	17	-153	
3 s/c difference	-27	0	0	
> 3 s/c's	-48	0	0	
TOTAL		2100	17669	84.1%
	Limits			Result
Bias	0.30	-0.30		0.17
Slope	1.15	0.85		0.97
Number of validated carcases				2100
No. of carcases failed to classify				0
% failures				0.0%

New Machine - 2002 Eq's

Conf

	Points	No. carc.	Score	% score
no difference	10	1432	14320	
1 s/c difference	6	642	3852	
2 s/c difference	-9	23	-207	
3 s/c difference	-27	3	-81	
> 3 s/c's	-48	0	0	
TOTAL		2100	17884	85.2%
	Limits			Result
Bias	0.30	-0.30		0.01
Slope	1.15	0.85		1.00
Number of validated carcases				2100
No. of carcases failed to classify				0
% failures				0.0%

New machine mixture of Eq's

Conf

	Points	No. carc.	Score	% score
no difference	10	1620	16200	
1 s/c differen	6	472	2832	
2 s/c differe	-9	8	-72	
3 s/c differen	-27	0	0	
> 3 s/c's	-48	0	0	
TOTAL		2100	18960	90.3%
	Limits			Result
Bias	0.30	-0.30		0.01
Slope	1.15	0.85		0.99
Number of validated carcases				2100
No. of carcases failed to classify				0
% failures				0.0%

The equations used in the new modified machine for fat were the 2002 equations only i.e. no combination with 2014 equations used for fat.

Old machine 2002 Eq's

Fat

	Points	No. carc.	Score	% score
no difference	10	949	9490	
1 s/c difference	9	964	8676	
2 s/c difference	0	174	0	
3 s/c difference	-13	13	-169	
> 3 s/c's	-30	0	0	
TOTAL		2100	17997	85.7%
	Limits			Result
Bias	0.60	-0.60		-0.14
Slope	1.30	0.70		1.11
Number of validated carcases				2100
No. of carcases failed to classify				0
% failures				0.0%

New Machine - 2002 Eq's

Fat

	Points	No. carc.	Score	% score
no difference	10	1250	12500	
1 s/c difference	9	792	7128	
2 s/c difference	0	55	0	
3 s/c difference	-13	3	-39	
> 3 s/c's	-30	0	0	
TOTAL		2100	19589	93.3%
	Limits			Result
Bias	0.60	-0.60		-0.05
Slope	1.30	0.70		0.89
Number of validated carcases				2100
No. of carcases failed to classify				0
% failures				0.0%

*The legal tolerances are the Accuracy must be >60% and the Bias for Conformation must be ±0.3 and ± 0.6 for Fat.

Annex III; Information regarding appointed neutral expert

Name: Ing. P.A.C.M. (Piet) van de Lindeloof

Nationality: the Netherlands

Education: High Agricultural School

Employer: Several organisations belonging to the Ministry of Agriculture, Nature management and Food Quality;

Acitivities in the field of classification:

Licenced classifier in pigs and bovines

Inspector, manager and trainer in the field of classification, price reporting and market support measures

Member of the European Union Inspection Committee (1992-2007)

Delegated classification expert at DG AGRI of the European Commission (2002-2004)

Expert/trainer in EU and national training programs like Better Training Safer Food (BTSF) and TAIEX (2004-now)

Project leader in project to set up classification inspection in Bulgaria (2005-2006)

Auditor at Council for Accreditation during inspections of Dutch classification organisation. (2006-now)

Chairman of Commission Quality management Classification (2013-now)