Errors of Interpretation and Clarity in Motion-Picture Standards

By E. K. CARVER

Although one of the rules in the writing of standards is that they should be so clear and definite that they are capable of only one interpretation, nevertheless there have been several cases in which our standards have been misinterpreted. In some cases the "fault" can be ascribed to the fact that the reader did not use perfect logic in interpreting them. The author believes that when standards are misinterpreted the fault is always with the writer of the standards. The remedy proposed is a discussion of purpose and use of the standards, and especially a discussion of tolerances and the reasons for setting them as they were set.

The most important features of a good set of standards in any field are probably these:

1. The particular things to be standardized should be carefully chosen so as to accomplish a definite and useful purpose.
2. The values, dimensions, or statements that become the standards should be accurate and practical.
3. The meaning of the standards should be unambiguous and easily understood.

This paper is concerned almost entirely with paragraph 3.

Since much of our learning is by experience, let us examine some of the motion-picture standards that have been misunderstood in the past and attempt to draw lessons from these misunderstandings. It is my belief that whenever standards are misinterpreted by competent engineers, the fault lies with the writer of the standards. The customer, or the reader in this case, is never wrong.

The first grave misunderstanding started in 1932 when the first proposed standard for 16mm sound film was published. The American industry agreed upon the standards and incorporated them in the drawing shown in Fig. 1. This drawing contains a great deal of information. It shows that we had planned to give up the perforations on one side of the film and have the soundtrack in place of them. It shows the width of the soundtrack, the space between the soundtrack and the picture, the placement of the soundtrack, etc. The word "TITLE," if it is properly interpreted, indicates that the soundtrack would appear on the righthand side of the screen if the projector gate were cut away so that we could see it. Now in 35mm film, the soundtrack is on the opposite side.

The Germans were developing their own sound projectors, and, wishing to follow the American lead, they started building projectors and published a drawing in 1934 which was very similar to ours. Instead of using the word "title" to indicate which side the soundtrack was on, they wrote it out. But since the Americans were so sure that the Germans had copied their standard, they did not immediately pick up the error. It was only after considerable time and money had been wasted that the disagreement was discovered and an agreement was finally reached.

Now according to my idea, the first error was committed by the Americans. Technically, perhaps, they did not commit an error except from the point of view that they failed to emphasize the change they had made. Instead of calling attention to the change in position of the soundtrack and discussing the reasons for the change they merely indicated it as briefly and concisely as possible by the position of the word "TITLE." It took some accurate thinking on the part of the reader to correctly interpret the meaning of this word.

Another misunderstanding of our standards came to light when the French delegate at the ISO conference pointed out that the French were having trouble in following the American standard for the position of the sound relative to the picture. The American standard says: "The separation of the sound and the corresponding picture shall be 20 frames plus or minus one-half frame." In large theaters the French had found it desirable to put the sound 21 frames or 22 frames ahead of the picture so as to allow the sound and picture to appear synchronized at the midpoint of the audience.

They did not wish to print the sound 21 or 22 frames ahead of the picture because they felt they were violating an accepted standard. In order to synchronize the sound with the picture at a midpoint in the theater, they found that they had to thread the film with a shorter loop, say 18 or 19 frames, between the picture and the sound, and many of the projectors would not accept such a loop. They assumed, of course, that when our standard said 20 frames, it meant that all films should be printed with the sound 20 frames ahead of the picture. This apparently is not what our standards group meant. They meant that 20 frames would synchronize the sound at the screen and that if people wished to synchronize the sound 50 or 100 ft away, they would naturally print the sound 21 or 22 frames ahead. This question is now being clarified.

Another standard which has been misinterpreted was the old standard for Winding A and Winding B. The standard reads: "When a roll of 16mm raw stock perforated along one edge is held so that the outside end of the film leaves the roll at the top and toward the right, winding A shall have the perforations along the edge toward the observer, and winding B shall have the perforations along the edge away from the observer. In either case, if the film is wound on a pool with a square hole in one flange and a round hole in the other flange, the square hole shall be on the side away from the observer."

This seems perfectly clear. It was designed so that film can be printed first in one direction and then in the other without rewinding.

There was no trouble until the film was needed on spools with one round hole and one square hole. The designation for this is perfectly clear in the standard, but as will be seen from Fig. 2 it is obviously not what is wanted for this type of printing. A winding similar to "C" in this figure would be required but this winding is not included in the standard.

This standard was misinterpreted by the users simply because they knew what they thought it ought to say, and so they assumed that this was what it said.

All three of these misinterpretations could have been avoided if it had been the custom to write standards with footnotes, explaining the uses, the reasoning that led to them, and any particular difficulties that the standards were designed to avoid.

In the early days of our standardization, there were several unwritten rules that guided our practice:

1. There must be no redundancy.
2. Explanations were not needed. We were not writing a treatise on good practice.
3. The drawings and figures were of prime importance. The descriptions should be as short as possible.

Presented on April 29, 1957, at the Society's Convention at Washington, D.C., by E. K. Carver, Eastman Kodak Company, Kodak Park Works, Rochester 4, N. Y.
(This paper was received on April 20, 1957.)

Table I. From American Standard Dimensions for 35mm Motion-Picture Short-Pitch Negative Film, PH22.93-1953 (*Jour. SMPTE, 62:* 89, Jan. 1954).

Dimensions	Inches
A	1.377 ± 0.001
B	0.1866 ± 0.0005
C	0.1100 ± 0.0004
D	0.073 ± 0.0004
E	0.079 ± 0.002
G	Not > 0.001
*H	0.082
I	0.999 ± 0.002
†L	18.66 ± 0.015

* A calculated value for a dimension not measured routinely in production.
† This dimension represents the length of any 100 consecutive perforation intervals.

4. All dimensions should have tolerances.

As the years have passed and standards have been revised, we find that we have drifted away from some of these rules. Footnotes have been added and the meanings have become clearer. The standards are easier to use. I believe there will be fewer and fewer misunderstandings in the standards that are written in the future.

There is one part of the standards, however, in which no improvement has been made. I refer to the tolerances, to the values we assign to them, and to the method of expressing them.

Let us look at some of our tolerances. Table I shows the tolerances for 35mm film dimensions taken from ASA PH22.93- 1953. You will note that practically all of the values show certain dimensions with plus and minus tolerances. In Table II, however, we have a similar set of dimensions except that one particular dimension, A, the width of the film, is expressed as $1.378 \pm^{0.000}_{0.002}$. What was the purpose of this change if the values are the same; why express one in one way and the other in another way?

The reason is that the standards

Table II. From American Standard for 35mm Film — Cutting and Perforating Negative and Positive Raw Stock, Z22.1-1936 (*Jour. SMPE, 30:* 261, Mar. 1938).

Dimensions	Inches
A	1.378 +0.000 −0.002
B	0.1870 ± 0.0005
C**	0.1100 ± 0.0004
D**	0.0780 ± 0.0004
E	0.134 ± 0.002
F	1.109 ± 0.002
G	Not > 0.001
L*	18.700 ± 0.015
R**	0.020

* L = the length of any 100 consecutive perforation intervals.
** This single style of perforation, known as the SMPE perforation, shall be used for all 35mm. film. It is the same as the perforation known prior to July 14, 1933, as the standard positive perforation.

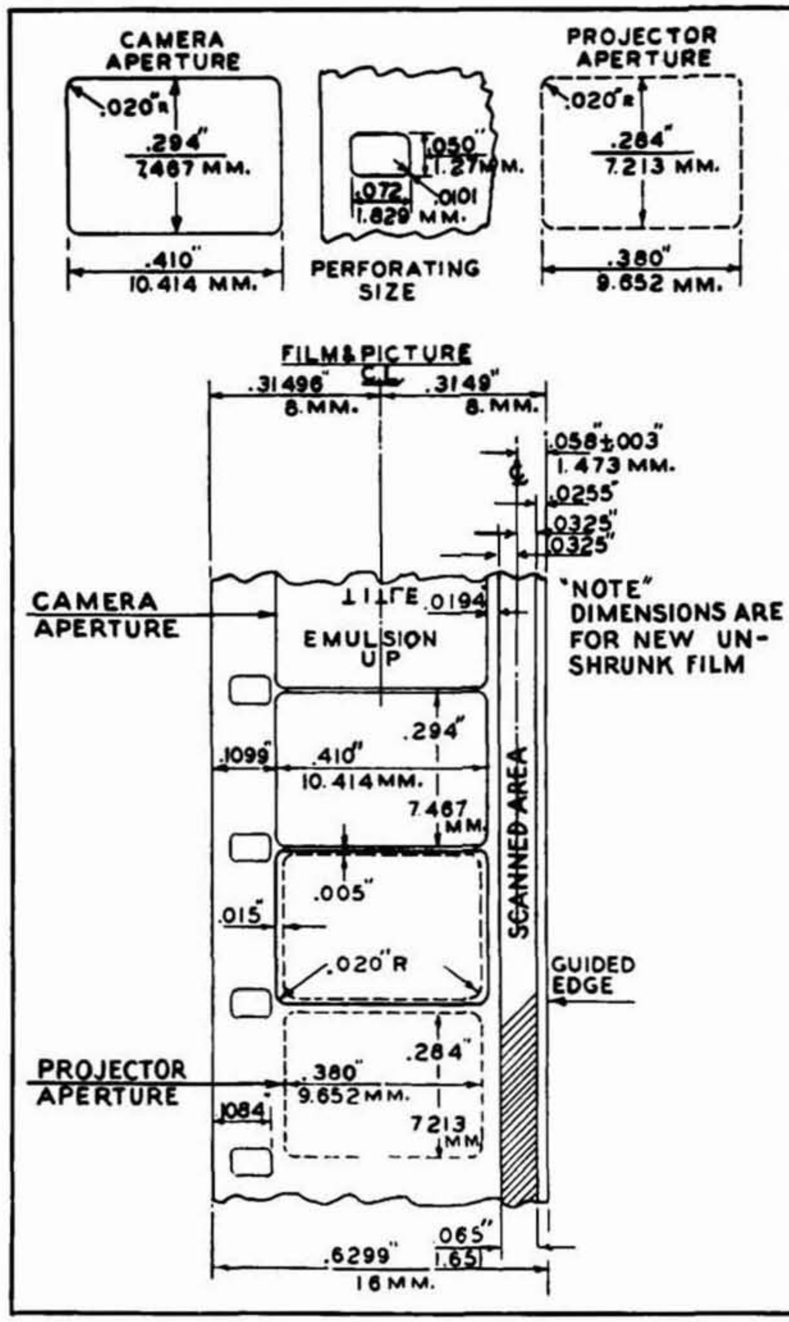

Fig. 1. Recommended standard, 16mm sound film (*Jour. SMPE, 19:* 478, Nov. 1932).

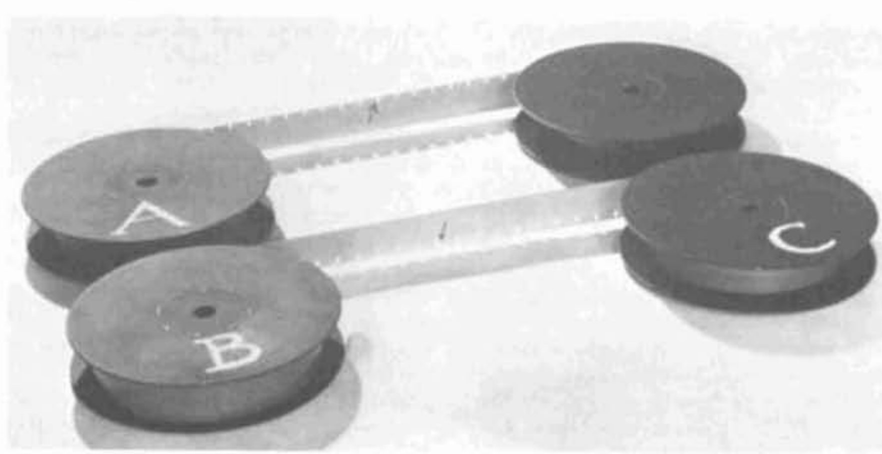

Figure 2

writers wanted to tell the reader that the upper limit was more important than the lower limit. They didn't want to come right out and say so in plain English because that did not seem to be the way standards are written.

They wished to say "the upper value is the one that must not be exceeded because if you exceed it, the film will probably stick in a gate or between flanges. You really ought to keep as far away from this value as you can."

However, there might be another interpretation that would be like this. "The upper limit is the important one. It is also the nominal value. Keep your dimensions as close to this as possible so as to avoid sloppiness and weave in some printer or sound recorder. Of course you hould not exceed this limit if you can help it, but keep as close to it as you can."

Now the point I wish to make is that there is no harm in using words to explain these things. If the standards writers have a meaning they wish to convey, let them say so directly and clearly.

Let us look at another standard: Fig. 3, the standard for 16mm reels. In this standard we have six ways of expressing tolerances. In most cases it is fairly clear what they mean, but there are some ambiguities.

You will note that dimensions A and B show plus zero and minus three-thousandths tolerance. R and S show maxima only; T shows a maximum and a minimum; U shows a symmetrical plus and minus tolerance; V shows minus zero and plus five-thousandths tolerance, while W at periphery shows an unsymmetrical plus and minus tolerance. Now these tolerances were not written in six different ways without a purpose. In some cases the purposes are perfectly clear, as where a maximum only is shown. But in the other cases it is not always so clear. Let us consider dimensions A and B. These are both dimensions for a hole through which a shaft is to go. Note that ordinarily it is the custom to give the hole a zero minus tolerance and a positive plus tolerance, indicating that the hole must under no circumstances be smaller than the shaft intended to go through it. But here we use a zero plus tolerance. There must have been some reason why the group who wrote this standard wrote it this way.

Perhaps we can throw some light on the question if we consider the standard for "Spindles for 16 Millimeter Motion Picture Projectors." Here it is stated that the diameter of the round section and the length of a side of the square section shall be 0.312 ± 0.003 inch. Thus the maximum shaft diameter and the minimum hole diameter will have a clearance of 0.001-inch. But it is still not clear why they did not specify the hole size as $0.316 \pm^{0.003}_{0.000}$. It must have been because they really wished to state that 0.319 inch was actually a preferred size.

American Standard for 16-Millimeter Motion Picture Projection Reels

ASA Reg. U. S. Pat. Off.
PH22.11-1953
Revision of Z22.11-1941 and Z52.33-1945
*UDC 778.55

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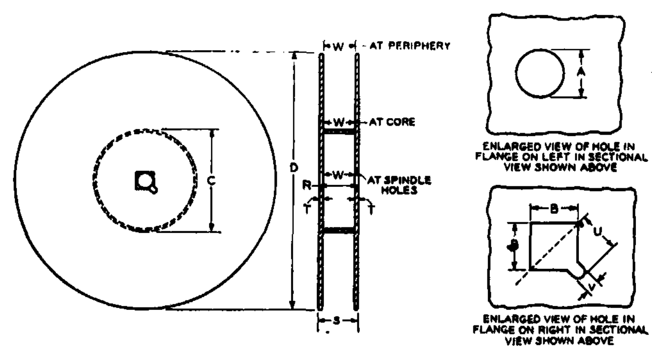

Table 1 See page 3 for notes.

Dimension	Inches	Millimeters
A	0.319 +0.000 −0.003	8.10 +0.00 −0.08
B	0.319 +0.000 −0.003	8.10 +0.00 −0.08
R[1]	0.790 maximum	20.06 maximum
S[2] (including flared, rolled, or beveled edges, if any)	0.962 maximum	24.43 maximum
T (adjacent to spindle)	0.027 minimum 0.066 maximum	0.69 minimum 1.68 maximum
U	0.312 ±0.016	7.92 ±0.41
V	0.125 +0.005 −0.000	3.18 +0.13 −0.00
W, at periphery[3]	0.660 +0.045 −0.025	16.76 +1.14 −0.64
at core[4]	0.660 ±0.010	16.76 ±0.25
at spindle holes	0.660 ±0.015	16.76 ±0.38
Flange and core concentricity[5]	±0.031	±0.79

Approved September 11, 1953, by the American Standards Association, Incorporated
Sponsor: Society of Motion Picture and Television Engineers

*Universal Decimal Classification

Fig. 3. First page of PH22.11-1953 (*Jour. SMPTE, 61:* 339, Sept. 1953).

They wished to have at least 0.004 inch clearance, but did not want much more.

Now I believe that all this could have been stated more clearly in footnotes. Footnotes would have the advantage of letting the reader know what was really intended rather than making it necessary to guess.

The case of dimension V (Fig. 3) is the same sort of dimension, namely, a hole or slot, and yet in this case it has a zero minus tolerance and a plus 0.005 positive tolerance. This seems to be perfectly regular. The slot is made to take a ⅛-inch key but a 0.005 tolerance is allowed in the larger dimensions.

We have shown that in fixing the tolerances for the various standards, the standardizing groups really do feel that some tolerances are more important than others. We have shown that they should state these relative importances in clear words rather than by the manner in which the pluses and minuses are used. We are still faced with the problem as to what criteria we should use in setting the tolerance values. In some cases they are important and in some cases, unimportant.

Sometimes close tolerances are difficult to meet and sometimes not. Should the tolerances be set so as to meet some minimum of picture quality, letting the refinements be a matter of competition, or should the tolerances be set to give optimum picture quality, permitting manufacturers to meet them if they can? These are difficult questions. The answer lies somewhere between the above extremes, but the best compromise will be reached in each case through a description of the needs for each tolerance and of the difficulties that will be encountered when tolerances are exceeded. Perhaps each standard will become a short treatise on its particular subject, but if it is a short one, and a clear one, it will contribute to the improvement of motion-picture production. In those cases in which the manufacturing tolerances are close to the quality tolerances the newer techniques of the quality control people can be used. Means and standard deviations can be specified.

I do not believe it is possible to sandardize on methods of standardization, as for example, when to use symmetrical tolerances and when not to use them. However, I do believe that there is a golden rule which says: "Write standards and tolerances for other people to use as you would like other people to write them for you."

Discussion

Deane R. White (E. I. du Pont de Nemours & Co.): There is a point that you did not mention with regard to one of your unsymmetrical vs. symmetrical tolerances that has come up and caused trouble at the international level. You had, in millimeters, 35.00 plus 0 minus 05. In the other case of the symmetrical tolerances you had 34.98 plus or minus 03. In this problem not only do we have this question that Dr. Carver has been speaking of — the "clear understanding," but when we come to express the tolerances, both in inches and in the metric system, we get into additional troubles in expressing tolerances. In the international standards currently under discussion that is one of the greatest problems that we face. When you express the tolerances in the two systems, you may not be specifying the same thing unless you are very careful. You may have to go to a tolerance specification with more significant figures than is desired by workers in either the English or the metric system.

James A. Moses (Session Vice-Chairman): I'm sure all of us who have worked in the various committees recognize the importance of the precautions and statements that Dr. Carver has made and I know of no other person who could give us better guide rules to help us determine how to make these tolerances.

Test Films — Standards at Work

By BOYCE NEMEC

Uniqueness of content sets one motion picture apart from any other. Yet to reach its audience at all, that same motion picture must be precisely standardized, a rigorous condition not imposed upon any other creative product. One of SMPTE's jobs is to determine "how standard." How this is done through test films is explained in this paper.

PUBLISHED transactions of one of the earliest meetings of the Society report on what seems in retrospect a very primitive problem in standardization — or more properly, the lack of it.

Camera work for a Department of Agriculture film had been assigned to two crews who were to work simultaneously in different parts of the United States, with films to be sent to Washington where the picture was to be edited. We must assume that each crew did its work properly and that footage sent in was acceptable because both were kept on the job until their individual assignments had been accomplished. All went well until the editor began roughing out the finished picture. The record is not clear, but either he or a projectionist learned about standards of interchangeability the hard way, for it was discovered that one of the cameras had placed the frameline on the centerline of a lateral pair of sprocket holes while the other had placed the frameline halfway between. The film could not be intercut.

Certain standards of interchangeability needed at that time did not exist. It was such needs as this that helped move a group of experimenters and practitioners in the then nearly 30-year-old "industry" to organize this Society in 1916 and to hold it together during its early shaky years.

Standardization was and is one of the Society's principal official functions. It moved ahead solidly if slowly. By 1922, film dimensions, and image size and location had been formally tied down. In the mid-twenties, the coming of sound introduced a new order of precision and imposed some new and rigorous standardization and interchangeability problems on engineers.

About the same time the American Standards Association entered the picture, bringing the benefits of national standardization experience plus the national and international values that attach to ASA accreditation.

The motion-picture industry was growing both at home and abroad. It had demonstrated a need and a desire for engineering standards, particularly those involving interchangeability, to insure the ready exchange of motion-picture films.

To meet this need the members of the Society of Motion Picture Engineers and later the active participants in the work of the Motion Picture Research Council contributed the practical experience and professional knowledge essential to technical accuracy and editorial competence in the drafting of standards content. The Society's Board of Governors and the committees on procedure of the American Standards Association became formal safeguard agencies insuring that all interested individuals were given equal opportunity to express their views on any standards proposal; the *Transactions* and *Journal* of the Society became the recognized medium for making standardization efforts and accomplishments known to a specialized worldwide audience.

Thus the essential elements in the process of standardization came into existence. A review of the history of some of the basic standards in use today will show that these elements functioned effectively.

A standard has been defined by Ralstone R. Irvine, an authority on the legal aspects of standardization, as "...simply a definition of a product or procedure in terms of certain features." And he continues: "Standardization, accordingly, is simply the process of reaching agreement on the form and content of such a definition."

Within these boundaries there is a continuing need for precision and uniformity in all dimensional references and tolerances. A need exists also for care and precision in the development of the supporting language.

Thus, we have defined a standard and have stated that (1) it must be technically accurate; (2) it must be as understandable as words will allow; (3) it must be the product of joint effort; (4) it must represent the views of all interested parties; and (5) channels must be available for making its presence known.

Test films, apparently, are standards which meet all of these conditions and have two additional virtues worth noting: they are self-contained test devices that, in effect, apply themselves and so are little subject to errors of

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Presented on April 29, 1957, at the Society's Convention at Washington, D.C., by Boyce Nemec, Management Consultant, 141 E. 44 St., New York 17.
(This paper was received on April 15, 1957.)