MAP-ACCURACY SPECIFICATIONS*

For planimetric and topographic maps and charts prepared by stereo-photogrammetric processes

I. Control Surveys

a. *Horizontal:* Each horizontal control station used in compiling the map shall be of sufficient accuracy in co-ordinate position (accurate in relation to the nearest first-order or second-order control stations, which are assumed to be absolutely correct) that its position on the map will not be in error by more than 1/200 inch (0.13 mm.), at publication scale.† (For example, if a map is to be published at a scale of 1:24,000, or 1 inch = 2,000 feet, the maximum error in co-ordinates of any horizontal control point used should be 1/200 of 2,000 feet = 10 feet.)

b. *Vertical:* Each vertical control point used shall be correct in elevation (correct with respect to the nearest first-order or second-order level control, whose elevations are assumed to be absolutely correct) to within less than 1/10 of the contour interval.

(The horizontal and/or vertical control points should be of such number and so distributed throughout the map sheet's area that the specifications dealing with accuracy of planimetric detail, and accuracy of contours and elevations, can be met. Thus, the minimum number of horizontal and vertical control points required, and their distribution, will be determined in each case by the limitations of the mapping method to be used.)

II. Plotting Projections and Horizontal Control

a. *Projection:* The projection lines of the map, at publication scale, shall scale correctly, both in over-all dimensions and relative to each other, as follows:

1. The original manuscript map should be preferably on metal-mounted or other nondistortable base, and the projection lines should all scale correctly within 1/150 inch (0.17 mm.).
2. If the manuscript map is plotted on drawing material subject to expansion or shrinkage, the same accuracy in plotting the original map should be maintained. In the reproduction process, however, a method should be used which will as far as possible eliminate shrinkage or expansion distortions, and furnish inking plates, engraving plates, or press plates with projection lines scaling correctly in over-all dimensions to within 1/100 inch (0.25 mm.).

b. *Control Plotting:* Each horizontal control point shall be plotted in correct position on the original manuscript map, with respect to the nearest projection lines, to within 1/150 inch (0.17 mm.).

III. Horizontal Accuracy of Planimetric Detail

Ninety-five per cent (95%) of all well-defined cultural and drainage features shall be plotted on the map in correct horizontal co-ordinate position within 1/50 inch (0.50 mm.), at the publication scale.

(If, for example, publication scale is 1:24,000, or 1 inch = 2,000 feet, this spec-

* Adopted by the American Society of Photogrammetry, January 18, 1940.

† If the *compilation scale* is the same, or nearly the same, as the *publication scale*, this accuracy should be required "at compilation scale."

ification insures that the scaled co-ordinates of 95% of the well-defined cultural features will be correct within 1/50 of 2,000 feet = 40 feet on the ground for this particular scale. No limitation is suggested for the remaining 5% of such points.)

IV. Vertical Accuracy of Topographic Detail

a. *Contours:* Eighty-five per cent (85%) of all elevations interpolated from the map's contours shall be correct within $\frac{1}{2}$ the contour interval. Not more than 5% of all elevations interpolated from the map shall show errors in excess of the contour interval. Also, any contour which can be brought within the above noted vertical tolerance by shifting its plotted location by 1/50 inch (0.50 mm.), in any direction, at the publication scale, shall be considered as correctly plotted.

b. *"Spot" Elevations:* All "spot" elevations shown on the map shall be correct to within $\frac{1}{4}$ of the contour interval; except that no "spot" elevation need be shown closer than to the nearest foot.

V. Sheet Edge Matching

All cultural, drainage, and topographic features between adjoining sheets, along common margin lines, or in overlapping areas, shall be correctly transferred from one sheet to another, and shall match with each other, to within 1/100 inch (0.25 mm.) with respect to the nearest projection line; except that the map qualities herein specified shall not be sacrificed in order to join maps of lower order of accuracy.

Comments, Notes, and Explanations

The preceding items I to V complete the recommended map-accuracy specifications. The following comments are offered in further explanation of the specifications—also suggesting possible future trends and problems.

1. *Suggestions Regarding Map Testing*

Sample testing of maps may often be found desirable and necessary to insure compliance with the specifications. If any map is indicated, from a relatively small sample test, to be substandard, it is suggested that further tests be made before rejection. More specifically, it is recommended, if the "test-profile" method is used on topographic maps, that the length of such test profile or profiles be equal at least to the width of the map sheet. If random "spot" elevations are used, they should be so distributed as to extend over at least 5% of the sheet's area before rejection; provided also that within this testing area there shall be an average of one "test shot" for each square inch of map area. Similarly, if horizontal co-ordinate positions of planimetric detail are believed to be substandard, the position tests should be extended over at least 5% of the map sheet's area before rejection.

Tests should be considered as being applied to the map at publication scale, regardless of compilation scale of manuscript map.

Tests by profile should be by transit-tape or transit-stadia traverse, originating and closing on co-ordinated positions, and of such accuracy that the plotted stations will be in error by not more than 1/200 inch on the map at publication scale. The elevations of the instrument stations, and plus stations on the line inserted for checking purposes, should be determined by methods that will assure the accuracy specified in I (b).

Tests by random spot elevations should be made in such manner that the elevations of test points will be of the accuracy specified in I (b).

Area tests are usually made by re-mapping small portions of the map at a larger scale, and then reducing the resulting drawing on a transparent sheet to the exact scale of the manuscript map or published map. This reduction should be superimposed on the map to be tested by the projection lines, and not by cultural or drainage features, thus revealing the *actual* position and elevation differences, rather than relative errors. The map used as the standard for comparison should be made under accuracy specifications that would apply to a map of not less than twice the scale and $\frac{1}{2}$ the contour interval of the manuscript map.

2. *Reproduction Method, as to Accuracy*

The method of reproduction used should be such as to lose as little as possible of the accuracy in the manuscript map, so that tests made on the reproductions would give *essentially* the same results as those made on the manuscript original. In the case of the manuscript map being on distortable base, a reproduction method should be selected, if possible, which will eliminate, or at least partially eliminate, the scaling errors caused by uneven expansion or shrinkage of the original. Thus, as an illustration, any reproduction process which permits transferring copies of original map to a true-projection plate, in small sections, results in correct-scale reproduction plates regardless of distortion in original.

3. *Plotting Originals on Larger Scale than Publication Scale*

There is a growing practice, especially in maps compiled by photogrammetric processes, to plot and compile the original manuscript map on a scale considerably larger than the proposed publication scale. This, it is true, is one way of helping to insure compliance with the specifications governing horizontal accuracy of planimetric detail at a reduced publication scale.

4. *Establishing Proper Contour Interval*

It is suggested, if the specifications as to contour accuracy are adopted, that they will, in considerable degree, govern the selection of the contour interval, or intervals, to be used on a map. When the publication scale and mapping method are established, and the characteristics of the terrain known, the proper contour interval to use, in order to comply with the accuracy specifications, usually becomes obvious.

It is also recognized, in the cases where a large number of quadrangle sheets are required to cover the mapping area, that it would be undesirable to change slightly the contour interval or intervals from sheet to sheet, merely to make it easier to conform to a contour-accuracy specification. In this connection, however, attention is called to the increasing use of two contour intervals on one map sheet. The smaller interval is usually $\frac{1}{2}$ (sometimes $\frac{1}{5}$ or $\frac{1}{4}$) the larger interval, and is usually differentiated from the larger interval by use of dotted or short dash lines. The use of the smaller interval, or half-interval contour is ordinarily limited to flat or gently sloping areas, or to critical features as summits, depressions, and saddles, where use of the larger contour interval alone does not properly bring out all of the topographic detail which the map scale could conveniently accommodate.

Still another practice, not quite so general, but which has been used and found practical in many city topographic surveys, is the use of three contour intervals on one sheet. Many city topographic sheets, for example, show 1, 2,

and 4-foot contours on the same sheet. Two-foot contours are considered the standard interval. One-foot contours, shown only in flat areas or critical places (as along pavement grades), are drawn dotted. The 4-foot interval is used only on extensive steep slopes, where the drawing of 2-foot contours would result in an almost solid brown mass, would add nothing to accuracy, and would tend to obscure and make less readable the planimetric and drainage details. The change from 2-foot to 4-foot contours is effected along an accentuated contour.

5. *Designations for Various Map Accuracies*

Recommendations for certain descriptive terms to designate different degrees of accuracy in maps is not considered to be a function of this Committee. Therefore, this Committee is not specifically recommending adoption of any particular designations, but is merely calling attention to the need of some such designative terms in the event accuracy specifications come into general use. If that happens, it is obvious that maps will inevitably be classified according to accuracy, and uniform designations will then be desirable.

As examples of such designations, maps compiled in accordance with specifications similar to these given herein might logically be described (not necessarily in title, perhaps in explanatory notes) as "standard," or "standard-accuracy" maps. Maps compiled to, or proving by tests to be of, any lower order of accuracy, might perhaps be described as "reconnaissance" maps, again not necessarily in the title, but in explanatory notes. Maps of a higher order of accuracy might be called "engineering" maps, etc. Or maps might be rated as of accuracy A, B, C, etc. Or the degree of accuracy might be described as first-order accuracy, second-order, third-order, etc. This matter of designative terms, if map-accuracy specifications come to be generally adopted, will likely warrant continuing study by the Society.

6. *Comments on the Proposed Contour Specifications*

The specifications on contour accuracy suggested herein are perhaps in the nature of a compromise. It is true that many topographic survey contracts have been let, and successfully executed, which require that 90% of the elevations interpolated from the map's contours shall be correct within $\frac{1}{2}$ the interval. It is also believed, however, that a majority of the topographic maps executed in the past would prove by test to be less accurate than the specifications herein suggested. This Committee suggests that the time may come when it will perhaps be found desirable to raise the contour-accuracy specifications. The Committee does not believe (based on practical experiences from numerous current and previous mapping projects) that these recommended specifications are ever likely to prove too severe for practical map making and best map use.