CODE OF RECOMMENDED PRACTICE

for

STANDARDS OF ACCURACY OF MAPS

Prepared by

THE CONNECTICUT TECHNICAL COUNCIL, INC.

Approved by the

STATE BOARD OF REGISTRATION

for

PROFESSIONAL ENGINEERS AND LAND SURVEYORS

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FOREWORD

In January 1943 the State Board of Registration for Professional Engineers and Land Surveyors presented certain problems involving the accuracy of maps to The Connecticut Technical Council and requested suggestions as to the solution.

Consideration by the Council indicated two possible procedures:

1. Legislative Action.

2. Adoption of a Code of Recommended Practice for Standards of Accuracy of Maps.

The latter procedure was adopted with the belief that voluntary action along ethical lines was preferable to compulsion which would result from legislative action.

A committee of eight registered engineers and land surveyors was appointed with instructions to proceed with the preparation of a code.

The Code prepared by this Committee covers maps and plans which may become public land records, be used as court evidence or represent data acquired, assembled or calculated for a client by a land surveyor. If properly established and followed these standards will be decidedly helpful, not only to the map maker and his clients, but also to those who may in the future use such maps.

The general purpose of the code is to present uniform methods and procedures by which maps may be classified according to specified degrees of accuracy and to indicate to all map users the accuracy of any map by reference to its classification. It also will place limitations on maps for purposes not anticipated by the surveyor when survey was made.

Use of code classifications will tend to reduce or prevent unfair competition. It also will permit the surveyor to present standards which are considered as meeting the requirements of his client.

By following the basic procedure outlined, using the specified instruments in proper adjustment the skilled surveyor may obtain the specified accuracy.

In establishing classifications consideration was given to the equipment and methods in relation to the type of project, the available funds and the purpose for which map is required. No complete description of surveying techniques is given under "Procedure" nor can definite information be given as to the method of determining the classification for a particular project. Experience must be acquired to select the proper classification and assure the necessary checks and refinements consistent with the specified accuracy.

In applying code standards there may be many surveys and maps whose original specifications were indefinite as to accuracy and scope. In such cases the results must be a compromise between economical production and the needs of the user. The code classification will however be of definite assistance to future users of the map.

Too much emphasis cannot be placed on the selection, care and maintenance of instruments and their effect on survey accuracy. Theodolites, transits, levels, alidades, etc. should be regularly checked for accuracy and kept in proper adjustment. Surveying textbooks or instrument makers' publications describe methods of making minor adjustments but major instrument service should be sought at the maker's factory or from instrument experts. Steel tapes should be compared at least every six months with a standard tape to check their true lengths.

Careful field work with good equipment is frequently nullified by poor notes and improper records. Care in this respect minimizes questions of interpretation and return trips to the field. Field notes which comprise the permanent record of the survey should be complete, clear and understandable by any one familiar with the principles of surveying.

Much could be said regarding office methods, for here the survey becomes a map, and accuracy and clarity are paramount. All computations should be checked and, if possible, independent computations made by two persons. Plotting by coordinates is recommended as the most accurate method for plotting large areas even if the basis is assumed. If the map is to be recorded, it should meet local requirements as to size, etc. To comply with rules of the State Board of Registration the land surveyor's seal should be impressed on all maps submitted to clients or for record or other public use.

Much of the above is elementary and nothing new has been presented, but no one can go wrong if the proper fundamentals are followed.

Voluntary adoption of the code by all Connecticut land surveyors, registered or otherwise, is recommended by both the Registration Board and the Technical Council. Such action will do much to impress clients and the public with the fact that a code based on ethical principles and standardized procedure is a working substitute for compulsory legislation in this period of multitudinous rules, regulations and laws.

The Code Committee has recommended to Technical Council that a standing committee be appointed to review the code from time to time and report to what extent it is being followed, whether or not it is effecting the desired results and to recommend such changes as may be necessary to accomplish its purpose. If after trial and possible modification, the Code is accepted by a majority of the Engineers and Land Surveyors but voluntary procedure does not prove completely effective, the Committee will recommend that Technical Council sponsor the necessary legislation to make it a law.

Acknowledgment is made of the cooperation and service rendered to the profession by The Connecticut Society of Civil Engineers, Inc., and Connecticut Section of the American Society of Civil Engineers for defraying the cost of printing this code.

CODE OF RECOMMENDED PRACTICE
FOR
STANDARDS OF ACCURACY FOR MAPS

The purpose of this Code is to prescribe procedures by which the accuracy of maps will be made apparent to all persons using them.

To obtain this result, every map should indicate the method of control employed in its preparation, by reference to one of the following classifications.

CLASS AA—PRECISE TRANSIT SURVEYS

PURPOSE

To present data in map form with the highest degree of accuracy in

a. Control surveys, both vertical and horizontal, which may be established by state, municipal or town such as the State Coordinate System for which United States Coast & Geodetic Survey has compiled tables and manuals.
b. The work of certain metropolitan districts.
c. Surveys of large areas where the highest degree of accuracy is deemed justifiable;
d. Surveys in the centers of large communities where land values are high and consistently high accuracy is necessary to control boundaries of valuable properties.
e. The permanent layout and maintenance of the position of streets and other important public works.

INSTRUMENTS AND EQUIPMENT USED

Theodolite or transit (reading to thirty seconds or less).
Invar tape or steel tape.
Telescopic precise level.
Invar rods.
Spring balance.
Thermometer.

PROCEDURE

Triangulation:

Determine exact location of all points by field reconnaissance.

Select points which will result in a suitable strength of figure.

Permanently monument all points directly located by triangulation.

Measure base lines by precise methods using invar or steel tapes and make proper corrections for reduction to horizontal, temperature and absolute length of tape.

Measure angles by directions or repetitions with the equivalent of six sets by the repetition method.

Use transits, reading to thirty seconds or less in the measurement of angles for first order triangulation.

Check triangle closures and apply the sine to side equation tests to the appropriate figures.

Make azimuth observations.

Distribute errors of closure in the field work by the method of least squares.

Compute plane coordinates for the resulting positions.

Traverse:

Permanently monument traverse stations in intervisible pairs located by careful field reconnaissance with proper connections to triangulation.

Repeat angle measurements; one or two sets per angle.

Use precise measurements in taping.

Adjust field measurements by the method of simultaneous weighted junction points or by the method of least squares.

Use tapes of known true length for base lines or first order traverse lengths, correct for slope and temperature and use proper tension.

VERTICAL CONTROL

Protect instrument from wind and sun.

Use invar rods.

Double run and check lines for accuracy.

Adjust field work by method of least squares.

SURVEY ACCURACY

Standards of accuracy for this type of survey will be found in American Society of Civil Engineers' Manuals Nos. 10 and 20, entiled "Technical Procedure for City Surveys" and "Horizontal Control Surveys to Supplement the Fundamental Net."

MAP ACCURACY

Refer to sources listed under Survey Accuracy.

CLASS A-1—TRANSIT SURVEY

PURPOSE

To present data with a high degree of accuracy in

a. Maps showing location, property and development surveys of the better type, carefully executed with equipment in proper adjustment and with proper attention to the reduction of errors.

b. Maps involving smaller areas than those of Class AA with an accuracy lower than that of Class AA.

INSTRUMENTS AND EQUIPMENT USED

Transit or plane table with telescopic alidade.

Telescopic level.

Steel Tape.

Thermometer.

PROCEDURE

Base maps on closed and adjusted traverses and show only accurately measured lengths and directions or computed lengths and directions based on the closed traverse.

Use a transit or plane table with telescopic alidade with suitable control in locating details or sketching contours.

Use points established by tape traverse for horizontal control.

Use bench marks established by telescopic level for vertical plane table control if large area is involved.

Indicate deed references and deed dimensions on map although they may differ from the results of the survey.

Note on map data from a previous survey or from work by others, indicating if any of previous data has been checked or whether any differences have been discovered.

Note on map level datum used.

SURVEY ACCURACY

Traverse.

The position closure after distribution of azimuth errors should not exceed 1:10,000.

Levels.

Discrepancies between forward and backward runs should not exceed four one hundredths feet times the square root of length of section in miles.

MAP ACCURACY

The limits of error in any map shall not exceed 1/10 inch between points as scaled on the original map. Reproduction methods by wet processes and so-called blue prints, and other copies may show greater over-all errors due to distortion caused by moisture and therefore should not be scaled.

The elevation error shall not exceed one half the contour interval.

A convenient check of contour accuracy is to run a test profile across a mapped area. Then plot this profile and compare it with a profile scaled from the map. At least 90% of the points tested should be correct within one-half the contour interval.

CLASS A-2—TRANSIT SURVEYS

PURPOSE

To present data with a reasonable degree of accuracy in Maps showing location, property and development surveys executed with equipment in proper adjustment and with reasonable attention to the reduction of errors. (Note: Maps of small four-sided building lots may be considered in this classification if only two of the interior angles are read and all lengths found consistent with recorded data.)

INSTRUMENTS AND EQUIPMENT USED

Transit or plane table with telescopic alidade.

Telescopic level with hand level for secondary elevations.

Steel tape or stadia.

PROCEDURE

Make temperature and slope corrections to distance measurements.

Adjust closed base line traverses.

Show all necessary data as clearly and completely as on maps of higher accuracy.

Use proper methods to obtain the Standard of Accuracy.

SURVEY. ACCURACY

Traverse.

The position closure after distribution of azimuth errors should not exceed 1:5,000.

Levels.

Discrepancies between forward and backward runs should not exceed one tenth times the square root of the length of section in miles.

MAP ACCURACY

The limits of error in any map shall not exceed 1/10 inch between points as scaled on the original map. Reproduction methods by wet processes and so-called blue prints, and other copies may show greater over-all errors due to distortion caused by moisture and therefore should not be scaled.

The elevation error shall not exceed one half the contour interval.

A convenient check of contour accuracy is to run a test profile across a mapped area. Then plot this profile and compare it with a profile scaled from the map. At least 80% of the points tested should be correct within one-half the contour interval.

CLASS A-3—TRANSIT SURVEYS

PURPOSE

To present data with suitable degree of accuracy in maps showing surveys of farms, pastures, wood lands, etc., or tracts whose value does not justify the use of more precise methods.

INSTRUMENTS AND EQUIPMENT USED

Transit or plane table with telescopic alidade.

Telescopic level with hand level for secondary elevations.

Tape (steel or cloth) or stadia.

PROCEDURE

Adjust closed base line traverses.

Use stadia methods employing procedures to obtain the Standard of Accuracy.

Show all necessary data as clearly and completely as on maps of higher accuracy.

SURVEY ACCURACY

Traverse.

The position closure after distribution of azimuth errors should not exceed 1:1,000.

MAP ACCURACY

The limits of error in any map shall not exceed 1/10 inch between points as scaled on the original map. Reproduction methods by wet processes and so-called blue prints, and other copies may show greater over-all errors due to distortion caused by moisture and therefore should not be scaled.

The elevation error shall not exceed one half the contour interval.

A convenient check of contour accuracy is to run a test profile across a mapped area. Then plot this profile and compare it with a profile scaled from the map. At least 70% of the points tested should be correct within one-half the contour interval.

CLASS B—RECONNAISSANCE SURVEYS

PURPOSE

To present data quickly and economically to show reasonably good distances and elevations in indicating possible routes for power lines, drainage lines, highways or similar projects through unmapped areas or as a basis for preliminary cost estimates or to check the general feasibility of the project.

INSTRUMENTS AND EQUIPMENT USED

Compass or plane table with simple alidade.

Cloth tape, link chain, stadia or pacing.

Hand level or surveying barometer.

PROCEDURE

Use instruments in various combinations as conditions require. Comprehensive adjustment of traverse to major plane coordinate systems, where latter are encountered, is not recommended.

STANDARDS OF ACCURACY

None.

CLASS C—AERIAL RECONNAISSANCE SURVEYS

PURPOSE

To provide quickly and with a fair degree of accuracy and detail photographic maps of large areas or terrain difficult to survey with usual methods for use in preliminary consideration of large projects.

GENERAL TYPES OF MAPS

The following general types of maps are in current use.

1. Topographic maps constructed from nearly vertical aerial photographs by means of the multiplex projector or other steremetric equipment compensating for tilts.

2. Planimetric maps compiled from vertical aerial photographs by means of vertical projectors with the work based upon carefully constructed schemes of secondary control by conventional methods of radial plotting.

3. Reconnaissance maps compiled from aerial photographs by methods similar to the so-called "tri-metrogon method".

4. Controlled mosaics, based upon a scheme of secondary control by radial plotting, with the photographs copied to uniform scale.

5. Semi-controlled mosaics made by the "azimuth line" or similar method.

6. Uncontrolled mosaics and simple reproduction of aerial photographs with or without enlargement.

CLASS D—COMPILATIONS

PURPOSE

To present a map compiled from other maps, deed dimensions and other sources of information without field checking.

STANDARDS OF ACCURACY

None. Control dependent on source control.

CLASS E—SKETCHES

PURPOSE

To present approximate data or detail, drawn free hand or otherwise, on maps made without field control, not to scale, but on which certain dimensions may be indicated.

STANDARDS OF ACCURACY

None. No field control.

certified substantially Correct & in accordance with Class D Standards of Connecticut Technical Council

MAPS—GENERAL DATA

METHODS OF SHOWING DIRECTION OF NORTH

Each map or sketch should have an arrow or similar device to indicate the direction of north and to afford a simple means for orienting the map. If the direction of north is taken from an atlas or is transferred from another map or is made by some method of estimation without an instrument of known precision, the indicated direction of north should be accompanied by the words "Approximate North" or "North from Atlas" as the case may be.

TITLES ON MAPS

Every map should have a title or notation thereon which will indidicate

Type of property or project.

Name of Owner.

Location.

Scale.

Date of original.

Dates on which revisions were made.

Data on which map is based.

CERTIFICATION OF CODE CLASSIFICATION

Name of Surveyor.

Imprint of Registration Seal of Surveyor (Required under Rule 10 of State Board of Registration for Professional Engineers and Land Surveyors).

Suggested form of certification.

I hereby certify this map to be substantially correct and in accordance with, Class of Code of Conn. Technical Council, Inc. (A rubber stamp may be used if desired.)

NOTATION ON MAPS

All notations should be terse and clear. (Typical examples are presented below.)

1. Surveyed as occupied or according to evidence of occupation.
2. Surveyed as the fences now exist.
3. Surveyed as found in possession.
4. Boundaries shown are those indicated on the ground by John Doe on April 8, 1940.
5. In the opinion of neighbors, this monument has been disturbed since 1900.
6. Encroachments below grade are not shown hereon, if any exist.
7. Elevations refer to mean high water.
8. Grades shown at points "A", "B", "C", were furnished by the City Engineer.

COMMITTEE ON STANDARDS OF ACCURACY OF MAPS

Jay H. F. Clark, Chairman
Henry W. Buck, Vice Chairman
Charles W. Cooke, Vice Chairman
Roger C. Brown
Charles A. Cahn
A. S. Lynch
Theodore F. Neuhaus
Frederick P. Stabell

APPROVAL BY CONNECTICUT TECHNICAL COUNCIL, INC.

At a meeting of the Connecticut Technical Council held on December 18, 1944, it was

VOTED. That the Code of Recommended Practice for Standards of Accuracy of Maps as prepared by the Committee on Map Accuracy be approved, and

That said Code be submitted to the State Board of Registration for Professional Engineers and Land Surveyors for its consideration and recommendations as to method of presenting it to the Land Surveyors in the State, and

That the Committee on Map Accuracy be continued as a standing committee to consider and report on suggestions for the improvement of the Code, its acceptance by Land Surveyors, and to determine prior to the 1947 General Assembly whether a legislative act appears necessary to make it effective.

Charles S. Farnham, Chairman.

Attest:
G. E. Hulse, Secretary

APPROVAL BY STATE BOARD OF REGISTRATION FOR PROFESSIONAL ENGINEERS AND LAND SURVEYORS

At a meeting of the State Board of Registration for Professional Engineers and Land Surveyors, held on December 28, 1944, it was

VOTED. That the Code of Recommended Practice for the Standards of Accuracy of Maps prepared by the Connecticut Technical Council, Inc., be and hereby is approved, and

That the Secretary be instructed to mail copies of the Code to all registrants holding combined Professional Engineer and Land Surveyor Certificates or Land Surveyor Certificates only, and to all Town Clerks within the State, and

That the Secretary be instructed to express the appreciation of the Board to the Connecticut Technical Council, Inc., for its cooperation in preparing and presenting the Code, and to the Connecticut Section of American Society of Civil Engineers and The Connecticut Society of Civil Engineers for defraying the printing costs.

James A. McElroy, Chairman.

Attest:
W. K. Simpson, Secretary.