

# Design Standards Letter

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Section/Plan No.: **None**

Subject: **Photogrammetric Field Surveys Revised Procedures**

Body

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**TO ALL DIVISION, DISTRICT AND URBAN ENGINEERS:**

**We have gained a great deal of knowledge during the last two winters on field work for photogrammetric surveys. As a result, we are furnishing you modified procedures for personnel doing this type of work. This letter will supersede General Letter No. 21, 1958 and Design Letter No. 18, 1959.**

**Pre-Flight Survey**  
**Horizontal Alignment**

**The centerline of the proposed route is established in accordance with standard procedures using extra precautions to insure the accuracy required by the Photogrammetric Unit.**

**The angles of intersection of tangent lines must be correct in magnitude to within one minute and correct in direction. To assure this accuracy, the intersection angles are measured by the following method, or one that will provide an equally accurate check:**

**With the plates set at "0" degrees and the telescope inverted, a backsight is taken on the back tangent. The telescope is plunged, turned, and the angle read and recorded. The lower plate is then loosened, the telescope turned, and another backsight is taken on the back tangent with the telescope normal. The telescope is then plunged, the angle turned, read, and recorded. Care is exercised to see that both readings are made at the same vernier. The magnitude of the second reading should be twice that of the first reading within one minute. If not, the process is repeated. Some other member of the party checks the angle, the direction right or left, and the recording of the notes.**

**When the P.I. of the curve is inaccessible, the chaining of the base line and the measurement of the angles necessary for the proper calculation of the curve data should be accomplished with particular care.**

To insure that no slight angle is introduced in the line, all extensions of tangents are double-centered.

All curves are run by the deflection angle method.

### Horizontal Measurement

The absolute maximum allowable error for chaining is 1' in any 1000'. This accuracy should be easily obtainable by using proper techniques.

A hand level is used to assure level chaining. This is especially important where the terrain is such that the chain must be broken often. Heavy chaining plumb bobs are necessary for both the Head Chainman and Rear Chainman.

Proper and particularly uniform tension on the chain is important. Approximately 20 pounds of pull should be exerted on a 100' chain when supported at the ends only.

It is important that the Head Chainman accurately mark the point to which the chained distance is measured. When a stake is used, the exact point should be marked in pencil by the Head Chainman. Where redheads are used in dirt, the center of the nail is normally used. Where nails or redheads are used in blacktop or gravel road surfaces, it is often necessary that the Rear Chainman be informed as to the point of the nail head on which the actual point lies.

The Rear Chainman shares with the Head Chainman the responsibility for correct horizontal measurement. He should check and call out the station occupied and check the station called out as the Head Chainman sets the point. Conscientious and cooperative work by these two men will increase the speed and accuracy of the ground survey.

The chain should be free of kinks and splices, and the numbers should be in such a condition as to be easily read.

### Air Targets

Two types of air targets have been approved for use in this work. Muslin or flagging (white) is to be used on relocations or locations not adjacent to existing roadways. Paint is to be used where the line crosses roads or coincides with the existing roads. Muslin and paint should both be available at the District garage.

One foot by six foot muslin strips are used to form a cross, with the center of the cross being placed on the point being targeted. When it is necessary to mark a point near a fence line or similar barriers, the strips are to be placed in an "L" shape as shown on the accompanying diagrams. The point of the "L" is to be placed on the point being targeted. The targets are to be secured as shown in the accompanying diagrams.

Where the center line crosses or coincides with an existing road, a painted circle as shown in the diagrams is to be used on the roadway. This paint is to be regular center line or traffic marking paint as noted on the diagram. If for some reason a painted target is undesirable, muslin targets may be used and offset from the center line. The station, plus, distance right or left, and the angle must be recorded in the field books.

The shape of the target should be changed every fourth or fifth target. Where muslin is being used an "L" target may be used in lieu of the + target. Where paint is being used a painted + with the same dimensions as suggested for the muslin targets may be used.

Unless specific information is received for an individual project the targets should be placed on the center line at 500' or 600' intervals, with a maximum distance between targets of 700'. In areas of proposed interchanges the center line of the crossroad should also be targeted.

The exact station, shape, and general description of the target, including the approximate distances and directions to permanent photo-identifiable objects, are recorded in a field book. Targets are to be placed on each P.C., P.T, and on easily accessible P.I.'s. Necessary additional targets to satisfy the required maximum interval should be, when possible, placed on stations.

Targets must be visible from the air. All underbrush and weeds are removed adjacent to the targets. The target should be placed so that it is not obscured by shadows. Care should be taken to place the targets where they will be least likely to be disturbed by animals or curious people. Targets are to be set so that the time lapse between the setting of the targets and the flying is held to a minimum. If the time lapse is of such duration as to cause doubt as to the target condition, the targets are checked immediately prior to flying.

The cloth panels should be torn to the proper size before going to the field. The survey party can be split into two-man groups for placing targets.

Normally, targetting will be done and the route photographed after the alignment is complete. When necessary, targetting and photographing may take place after the preliminary line has been plugged through, but before stationing is established. In this case, targets are placed on the proposed center line at an estimated 500'-700' interval. The point over which the target is centered must be either permanent in nature or tied in so that it can be re-established and the stationing of it obtained when the transit line is run. This procedure should be used only when approved by the main office.

The district will be notified by this office when we have obtained the photography and we will at this time request the alignment and target information.

### Post-Flight Survey

The post-flight survey is made with the aid of aerial photographs furnished by the

**Photogrammetric Unit. The inked and stamped markings on these photographs are explained under other headings in this letter. A series of numbers will appear along the top of the photographs. These are explained in the following example:**

**96 67 26 1 109 450 2 12 60**

**96 - County number (St. Louis)**

**67 - Route**

**26 - Roll of film (for filing purposes only)**

**1 - flight number ) These are the figures that the field party will**

**109 - Exposure number) be most concerned with**

**450 - Approximate scale of photographs (1" = 450'**

**2 12 60 - Date of photography**

**A row of instruments appear along the right side of the picture. These are, from top to bottom: Level bubble, clock, altimeter (marked in meters), and a fourth instrument which shows the camera serial number, a counter which registers shutter openings, and the focal length of the camera in millimeters.**

### **Horizontal Control**

**If the pre-flight survey work is accurate and the air targets properly set and not destroyed, there will be no additional horizontal control necessary after flying. If some of the air targets are destroyed before the flight is made, it may be necessary to locate certain photo-identifiable points in the field. These points will be indicated on the photographs furnished the districts and will be marked with a "green" circle on the front of the photograph and described on the back of the photograph. The field survey party will then establish the position of these points in the field and record their position in the field book. This position will normally be recorded as a center line station plus, and a distance right or left. It is very important that this distance be determined accurately. If the point is not close to the center line, a closed traverse will be necessary in order to accurately plot the control point on the manuscript. A transit is always used to measure the angle between the center line and the point. A sketch showing the location of the point should be shown on the back of the photo and in the field book.**

### **Vertical Control**

**Bench marks and center line profile are established by standard procedures. Ground elevations are obtained at each station and at every P.C. and P.T. This will provide elevation information at the targets and will assist in the scale solution of the stereo-compiler. The bench levels and center line profile may be secured either prior to or after flying. However, it will be necessary that the bench levels be established prior to locating lateral or wing-tipped vertical control points after the flying.**

**After photography the elevation of two or more wing control points must be obtained**

on each photograph. These are points some distance left or right of the center line. The elevation of which is necessary in order to properly establish the stereo-model in the plotter.

The location of these points is marked with a red circle on the front of the photograph and described on the back of the photograph by the Photogrammetric Unit personnel. Typical examples of these points are crossroads, center line of road at crest of hill, fence corners, and sidewalk intersections. The survey crew pricks the photograph with a pin or needle at the exact location where they obtain the elevation and at the time it is obtained. It is very important that a pocket stereoscope be used by the man pricking the point on the photograph. The points on the front of the photograph are identified by letters with subscript. The identifying numbers (flight and exposure), letters and description of the point are entered in the field book on the same line with the elevation of the point. The elevations of the lettered points, along with the page and number of the book used in obtaining the elevation, are recorded by the field personnel on the back of the photograph in the space provided. A three-man party will prove economical in obtaining vertical control, with the head rodman handling the pictures.

In running levels from the established bench marks to the above wing control points, the field party can often establish their turning points and obtain elevations on additional photo-identifiable points that they pass. The location of these additional points is marked with a cross on the photograph, pin pricked, and the elevation and description recorded in the field books and on the back of the photographs. If the points selected by the Photogrammetric Unit cannot be identified in the field, the location of two additional points must be made by the field party (one point on either side of the unidentifiable point in direction of line of flight).

The field books used in obtaining the horizontal and/or vertical control should be forwarded to this office along with the control photographs and the center line profile elevations as soon as the field work is completed. The profile notes will be returned to the district office at any time at their request.

### Bridge Surveys

The survey party should obtain high-water elevations at each bridge site and furnish the Photogrammetric Unit this information when the control photographs are returned. The location of the proposed valley sections should also be submitted at this time. A general location may be sketched on the pictures or detailed alignment may be submitted.

The Photogrammetric Unit will obtain the valley section and the 30' profiles right and left of center line with the exception of that part of the channel under water. Because the operator cannot read below the surface of the water, it will be necessary for the survey party to complete the channel below the lowest elevation furnished by the Photogrammetric Unit. For this reason, we will not attempt to obtain the typical channel section or the streambed profile 1000' right and left of center line.

**The practice of staking the valley section by the district before field check by the Division of Bridges will be continued and we will supply the necessary ties to the center line on the manuscript so that the valley section can be recovered in the field.**

### **Additional Survey Information**

**Only that survey work delineated above is to be done prior to the time that the Photogrammetric Unit furnishes the district with the manuscript. The manuscript can then be field completed by picking up any information (culvert size, underground utilities, etc.) not furnished by the Photogrammetric Unit. We believe this method will prove to be a savings in effort and money.**

### **Strip Maps**

**To eliminate the necessity of obtaining topography by field methods for the preparation of the strip map, enlargements of the aerial photography to a scale of 1" = 200' will be furnished on those projects requiring strip maps. Necessary topography may be traced onto the strip map from these enlargements.**

### **Urban Routes**

**The establishing of center line and placing of targets prior to flying may prove undesirable and/or unnecessary on certain urban projects. These projects will be handled as individual problems, with assistance being furnished by the Photogrammetric Unit.**

**Please advise if any parts of this letter are not understood.**

**C. P. Owens  
Engineer of Surveys and Plans**