U. S. FOREST SERVICE
Region 6

NOTES ON ADJUSTMENT AND USE OF OSBORNE PHOTO RECORDING TRANSIT

BY

W. B. Osborne
[Rob Hoeye]

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1. USE OF OSBORNE PHOTO RECORDING TRANSIT

This instrument combines and coordinates all of the principal features of a transit with a specially designed photo survey camera. It must be setup, adjusted, oriented, and handled in almost the same manner as' would be used with a standard transit.

The azimuth ring and leveling plate correspond to the lower plate and leveling head of a transit.

The camera box with attached vernier corresponds to the upper plate of a transit.

The alidade sight corresponds to the telescope mounted on the upper plate of a transit but with this difference. The alidade sight is detachable and may be mounted in any one of three positions on the camera by means of doweling pins. These three positions are at exactly 60 degree intervals and are correlated to known points on interior azimuth scales which will be explained later.

The Smith solar attachment when mounted on the side of the camera bears the same relation to the alidade sight when mounted in its center position that the same attachment bears to the telescope of a transit when it is mounted on the right-hand standard thereof. In both cases the vertical arc of the solar telescope is adjusted so that it is exactly parallel to the vertical plane of the alidade sight when in its center position or of the transit telescope.

If desired the telescope of the -- solar attachment can be used for direct sighting in lieu of the alidade in its center position. (To do this plunge telescope so that its forward end points toward front of camera and then release clamp on declination arc and set the reflector so as to form minimum obstruction to view through telescope, i.e., with glass surface parallel to longitudinal axis of telescope.)

Correlation Between Line of Sight as Determined by the Alidade Mounted in its Various Positions and the Interior Azimuth Scales of the Camera Which Register on the Negative at Time of Exposure. - The interior azimuth scales are in the form of narrow slits at 1 degree intervals which allow the light to pass through and register on the top and bottom margins of the negative at time of exposure. As in all conventional azimuth scales 5 and 10 degree intervals are distinguished by differences in length. Both scales starting with a center 10 degree graduation slit are graduated in both directions for a distance of 60 degrees with an extension of about 2 1/2 odd degrees. In other words, each scale covers an arc of 120 degrees plus an extension of about 2 1/2 odd degrees on each end. (These extensions are provided as a convenience for identifying, matching, or splicing adjacent pictures when taken at intervals of exactly 120 degrees.)

The center 10 degree graduation slit on both top and bottom scales have been adjusted, by means of interior set screws and verniers, so that they lie in a plane with the focal center of the camera lens and the slot and hair of the alidade sight when mounted in its center position. This means therefore that all objects lying in the vertical plane of sight of the alidade when mounted in its center position will register on the negative in alignment with the center 10 degree graduation slit of both top and bottom interior scales.

Now we cannot move these interior scales so as to agree with any random azimuth on which the camera might be sighted but we can rotate the camera until our center line of sight is on an exactly even 10 degree azimuth alignment (this means 0, 10, or any multiple thereof up to 350). Then since all objects lying in this vertical line of sight will register on the negative in perfect alignment with the center 10 degree graduation mark all other objects registering on the negative will be in correct relation to all of the other graduation markings of the entire scale. In other words, the camera must always be oriented exactly on an even 10 degree azimuth alignment at time of exposure in order to obtain the accurate positioning of the azimuth scale on the negative.

When the alidade is mounted in its right-hand position all objects lying in its vertical plane of sight will register on the negative in exact alignment with the last 10 degree marking at the fight end

of these scales. When mounted in its left-hand position all objects in its vertical plane of sight will register in alignment with the last 10 degree mark on the left end of the scales.

Now it should be noted that when the alidade is mounted in its right-hand position, and all objects lying in its vertical plane of sight are registering in alignment with the last 10 degree graduation on the right end of the interior scales or exactly 60 degrees to the right of the center. graduations, the actual line of sight on the landscape is 60 degrees to the left of the line of sight we would have if the alidade were mounted in its center position. This of course is due to the fact that the field of view is reversed in a camera, i.e., the sky registers on the lower edge of the film and objects which are located at the top left field of the included landscape register on the bottom right edge of the film as it is positioned in the camera with its emulsion side facing in. However, after the film is developed we reverse it end for end look through it from the glossy side. These objects now appear in the top left field as they will on the final prints. Hence it follows that when the a alidade is mounted in its right-hand position you are actually sighting on the left edge of the field that is going to be photographed and that all objects lying in the vertical plane of sight will be on the left edge of the final picture and in alignment with the first 10 degree graduation mark, reading from left to right.

In actual practice we utilize only the azimuth scale which is located at the bottom of camera when exposure is made since this scale (due to inversion of image) will have the sky as a background and show up much clearer than the one located at top of camera. The scale at top of camera has been provided for those cases where it may become desirable to use the camera in its inverted position, i. e., upside down.

The usual practice in taking panoramic pictures with this camera is to take them on certain standard arcs of the azimuth circle as follows: one on the arc 300 to 60; one on the are 60 to 180 and one from 180 to 300 and this is recommended for all but a few special cases. Special reasons for this are:

1. If these arcs are used the correct azimuth numerals, as will be explained late, can be photographed on the film at time of exposure (otherwise it will be necessary to keep a record and ink them in on the film after it has been developed).

2. It splits two views on azimuth 180 or due south. This makes it possible to take the complete panoramic view without making any exposures directly into the sun which usually detracts from clarity of film. This is done by photographing the arc 160 to 300 sometime before 11:00 a.m. and the arc 60 to 180 sometime after 1:00 p.m.

3. A uniformity of arcs covered is of some convenience in handling and filing pictures.

Explanation of Azimuth Numeral Marking

If pictures are taken on any of the three standard arcs above mentioned the proper azimuth numerals can be photographed on the negative at time exposure is made. This is done by means of a transparent tape carrying 3 series of numerals corresponding to three standard arcs mentioned and one series of blanks. Any one of the desired series can be shifted into openings or windows located directly below each 10 degree graduation mark so that they will register the negative at time exposure is made. The exterior controls for shifting these numerals into position are located on both bottom and top of camera and have four markings which are set in reference to a white line index.

The control on top of camera, however should always be set on B or blank since the numerals on this tape will not register correctly except when camera is inverted.

The control on bottom of camera should be set on 300 when camera is oriented to photograph the arc 300 to 60; on 60 when camera is oriented to photograph arc 60 to 180, and on 180 when oriented to photograph arc 180 to 300.

If pictures are taken on any other arcs, the procedure should, be as follows:

(a) Set azimuth numeral controls on both top and bottom of camera on B (blank);

(b) Orient camera on any even 10 degree azimuth alignment.

(c) Make a permanent record of this bearing including notation as to whether camera was oriented with alidade in its center position or in its right-hand position. (In the first case the bearing will apply to the center 10-degree graduation of picture and in latter case to first 10 degree graduation at top left edge of picture.)

(d) After the film has been developed this recorded azimuth should be marked in with India ink an the glossy side of the negative directly above the center or first 10 degree graduation mark as ~~preciously~~ [previously] explained. It is then a simple matter to ink in other azimuth numerals at 10 degree intervals. If the recorded azimuth was for the center 10 degree mark, numerals to the left will progress counterclockwise and those to the right clockwise. If the recorded azimuth was for first 10 degree graduation all of the others will progress clockwise. Name of station and other data can be inked in on margins as desired. Chipping off of ink can be prevented by applying a very thin coat of varnish to numerals only.

Explanation of Vertical Angle Scales

The vertical angle scales are tangent scales located at each end of the exposure field and register on the negative at time of, exposure. The zero point on both of these scales is defined by a pointer and two tiny holes. Both scales have been adjusted by set screws in top and bottom of camera so that the zero points of both scales and the focal center of the lens lie in a horizontal plane which is parallel to surfaces of the leveling blocks located on both top and bottom of camera. Hence it follows that if the camera is precisely leveled at time exposure is made all objects registered on the film that lie on a straight line drawn between the zero into on the vertical angle scales at each end of the picture were exactly level with center of camera lens when picture was taken. The usual practice is to scratch this level line across the face of the film after it has been developed.

If this line is scratched on the emulsion side of the film it will print as a black line. If it is scratched on the glossy side of the film it will print as a white line provided there is a dark background. Usually lines scratched on the emulsion side show up best.

In certain special cases where one desires to avoid scratching the film on account of scenic values the level line can be inked individual prints as desired. In scratching or drawing this line great care must be exercised to obtain an absolutely straight line that also cuts exactly the zero marks on the vertical angle scales, at each edge of picture. A small amount of practice on an old film or two will indicate kind or point and amount of pressure to use in scratching films. (Sharp point of a three faced divider leg makes a good scratching point.)

Normal and Inverted Positions of Camera

It will be noted that the camera is so constructed that it can be mounted on either of two faces.

It is said to be in its normal position when it is so mounted that the key post for winding film and the shaft for receiving fan governors are on its top face. When mounted in this position the lens is considerably below the center of the front opening and the field of exposure will cover a dip angle of 28 degrees and a plus angle of only 14 degrees. Usually the camera should be mounted in this position for taking all pictures from lookouts or other high points where it is desirable to obtain a large dip angle and usually only a small plus angle is needed to include all landscapes lying above the level of station occupied.

The camera is said to be in its inverted position when it is so mounted that the above-mentioned features are on its bottom face. When mounted in this inverted position the field of exposure covers a dip angle of only 14 degrees but a plus angle of 28 degrees. The camera should be mounted in this position when the desired view requires a large + angle and small minus angle as

would be illustrated by a picture of tall buildings or trees taken from street level and numerous other short-range scenic views of buildings trees, cliffs, waterfalls, etc.

Numbering Films Serially

If desired films can be numbered serially at time of exposure by manipulating exterior control disks located on bottom of camera directly above the azimuth numeral control. The first or smallest disk 'carries a series of numerals from 0 to 9 which register on the negative as unit numbers and are set by aligning desired numeral with white line marker or index. The second disk carries a series of numerals from I to 9 and a B (blank) which register on the negative in the second or tens column and are positioned by alignment with white marker previously mentioned. For example, to obtain the number 37 set first disk on 7 and second disk on 3.

Orienting the Azimuth Ring or Lower Plate of Instrument

There are four methods for determining a true meridian and correctly orienting the azimuth ring which corresponds to the lower plate of a transit.

(1) By sighting on some point, the true bearing of which is known and then setting and locking the azimuth ring on this reading. (The alidade may be mounted in either its center or its right-hand position but one must remember that in the former case the orientation and all subsequent readings are in reference to the center 10 degree mark of finished pictures, while in the latter case they will be in reference to the first 10 degree mark at upper left edge of pictures.) Errors in this case depend on accuracy of bearing used.

(2) By means of an observation on the sun with the Smith Solar attachment in the same manner as it would be made with this same attachment to a transit. In this case when the instrument is properly oriented on the sun the azimuth ring should be set and clamped on 0 degree if the alidade is to be used on its center mounting or on 300 degrees if it is to be used on its light-hand mounting. Error should not exceed 1 or 2 minutes.

(3) By direct observation on Polaris in much the same manner as such an observation would be made with a transit.

Preferably this observation should be made by direct sighting with telescope of solar attachment as previously explained, i.e. (setting refractor so as to afford minimum obstruction and plunging telescope so that its forward end is toward front face of camera.

Procedure would then be as follows:

Ascertain from an Ephemeris the direction and amount of departure of Polaris at time observation is to be made. Assume observation is to be made at 9:30 p.m., and that the departure at this time is 1 degree 25 minutes East. Sight directly on Polaris at this time and then set and clamp the azimuth ring on 1 degree 25 minutes if the observation is made with telescope of solar attachment and subsequent reading are to be made either with this telescope or with the alidade mounted in its center position. If, however, subsequent readings are to be made with the alidade mounted in its right-hand position the azimuth ring should be set on Az. 301 degrees 25 minutes, since in this case alignment of the alidade will be 60 degree left of alignment of solar telescope which is sighted on Polaris.

Direct observations on Polaris can be made with the alidade sight instead of the solar telescope if one will stretch an extra horse hair between top of front and rear sights by means of the two small holes that have been provided for this purpose. (This will give fairly accurate results but is not as good as using telescope of solar attachment).

In this case since the sight on Polaris is made directly with the alidade the Azimuth ring would be set and clamped on 1 degree 25 minutes when the alidade is in either its center or its right-hand position. In the former case the azimuth ring will be oriented in reference to the center 10 degree

mark of photograph and in the latter case in reference to the first 10 degree mark at left edge of picture. Error in cases where solar telescope is used should not be over 1 minute.

(4) By means of the magnetic trough needle which is mounted on alidade. In this case the alidade may be mounted in either its-center or right-hand position depending on whether one whishes to orient the azimuth ring in reference to center 10 degree graduation of picture or the first 10 degree mark at left edge of picture.

With alidade mounted in either position procedure-would be as follows:

(a) Release needle and revolve camera until needle rests on center mark. (Line of sight is now on magnetic north.)

(b) Set and clamp azimuth ring on the magnetic declination which is applicable to the location involved. (Example - if the correct declination for location involved is 22 degrees 15 minutes East the azimuth ring should be set and clamped on azimuth 22 degrees 15 minutes.)

This method should never be used when a high degree precision is desired since there is always the danger of considerable error due to local attraction, lack of knowledge as to normal deflection and inability to read needle closer than 15 or 20 minutes. (It has been noted that considerable local attraction is particularly apt to be encountered on sharp peaks or near high bluffs.) Error with this method ray be anywhere from a few minutes to 10 degrees or more,

Another makeshift method which may be used as a check on the magnetic needle method and frequently may prove to be more accurate is to obtain with a protractor from a map the approximate bearing to some distant and sharply defined peak that may be used as a target.

Summary

Main objective is to obtain the registration and accurate positioning of the azimuth and vertical angle scales on the negative at time of exposure.

To do this only three things are necessary:

1. Have line of sight oriented on an exact 10-degree azimuth alignment.
2. Have camera exactly level.
3. See that the proper azimuth numerals are provided either at time of making exposure or after film has been developed.

The rest is simply a matter of photography.

2. REMINDER OR CHECK LIST

Use of the following check list and systemized procedure is usually helpful in avoiding errors or omissions until manipulation becomes habitual.

1. Make sure that film is or has bean wound into place.
2. Set up camera and level precisely. (In case camera is to be used in inverted position the fan must be mounted before camera is set up.)
3. Orient azimuth ring by one of the five methods previously described and then clamp it as you would the lower plate of a transit.

4. Now rotate camera and sight on 3 or 4 sharply defined targets and record readings. Preferably they should be at least five or six miles away. (Purposes are for check checking against slippage in orientation; for convenience in making subsequent set ups or offsets, and for checking accuracy of registration on final prints if desired.)

5. Now rotate camera to proper position for photographing desired arc and clamp. Check or adjust level and then look through sights and pick out any target along this line of sight so that you can easily detect any slippage that might occur before ore making exposure. If you wish to photograph arcs 300-60; 60-180; or 180-300 the vernier should be set on 0, 120 or 240 if you are using alidade in center position, or on 30, 60, or 180 if you are using alidade in right-hand position. If you wish to photograph any other arc, rotate camera to desired position and then shift it to tight or left until vernier is on an exactly even 10 degree graduation then clamp camera and record the azimuth on which it is oriented including note as to position of alidade (center or right-hand).

6. Set azimuth numeral disk on bottom side of camera. Set it on 300 for arc 300 to 60; on 60 for arc 60-160; on 180 for arc 180-300; on B (blank) for any other arc. (Disk on top face of camera, should always be on "B".)

7. Set disks for serial numbering of films if desired.

8. Wind camera mechanism though door. (Door must be closed tight).

9. Consult "Harold Exposure Meter" and determine diaphragm setting and size of fan to be used.

10. Mount fan and put on housing cap. (When camera is to be used in inverted position fan must be mounted before, camera is set up and no housing is used.)

11. Make a final check of orientation and level adjustment.

12. Open front door and <u>set diaphragm to proper aperture</u>.

13. Release mechanism and make exposure. (To prevent stalling the release button should be held down for several seconds.)

14. Close front door as soon as exposure is completed.

15. Wind new film into position.

Picture completed and one is now ready to rotate camera 120 degrees in either direction to position for your next picture.

<u>3. FILMS AND EXPOSURE</u>

Film for the Osborne Photo Recording Transit should be ordered from Eastman Kodak Company. The proper size is 5-15/16"x100" six exposures per roll. Rolls must have extra long leaders and tailpieces, and special spacing of numerals on the paper backing. For this reason, orders should state that film is for use with the Osborne Photo-recording Transit and should he made up according to the specification on file at the Eastman factory.

Two types of film have been used (1) super-sensitive panchromatic which has a Weston rating of 25 and (2) infrared films.

The infrared film which is preferably used for obtaining detail in distant views is a comparatively slow film. It has no regular Weston rating but under average conditions is probably somewhere around 8 or about 1/3 as fast as ordinary Eastman verichrome film. This film however is sensitive to the infrared ray or that portion of the spectrum of radiation beyond the visible red and

hence invisible to the human eye. In photographing distant views it should always be used with a red filter which will result in rendering distant objects very sharply even if there is considerable haze and often show clearly objects that were visible to the eye. A letter from the Eastman Kodak Company states that photoelectric exposure meters are of-little or no use -in determining proper exposures for infrared sensitive film and that correct timing depends on atmospheric conditions and must be judged by experience.

Experience in using this film for taking graduated panoramic pictures from lookout stations has shown however that the Harold Exposure Scale, which is furnished with all Osborne Photo-Recording Transits, is a very satisfactory guide for proper timing on this kind of pictures if one will use "H" on the yellow disk for speed of film; "8x" on the green disk as filter factor for the light red or "A" Watten filter; and extreme distant view on the pink disk for subject factor. For example: Using these factors for proper exposure for normal landscape 1 to 15 miles away, with red filter attached, between 10 a.m. and 2 p.m. in April, May, June, July or August, would be a ~~45~~[32] stop and a ~~2 second~~ [no] fan if there was bright sunlight. If however at this same time the sun was completely obscured by clouds and the light dull the proper exposure would be a 22 stop with a 2 second fan. On the same day but at 8 a.m. or 4 p.m. a 32 stop should be used with the 2 second fan if there is a bright sun. If it were dull, one should use a 16 stop with the 2 second fan. [The above grossly over exposes the new (1949) film]

As in all photographic work extremely distant objects require a shorter exposure than nearby objects hence it is impossible to obtain a perfect exposure for both on a single picture. In pictures from lookouts exposures should be made so as to obtain the best possible detail of distant landscapes and as a result nearby dark objects will be somewhat underexposed. One peculiar characteristic of pictures taken with infrared film is that nearby green foliage often has a whitish appearance as if the foliage were covered with a white frost or snow. This is perfectly normal and cannot be avoided. Green timber or foliage in the distance will print dark as with ordinary film. Pictures taken from high altitudes 4,000 or 5,000 feet or more require a shorter exposure than at lower altitudes (suggest reducing diaphragm a little less than one space). Pictures taken into the sun should have a little longer exposure than those taken away from sun. (Suggest increasing aperture a little less than one space.)

If possible avoid making any exposure directly into the sun as previously explained. (i.e. by photographing the arc 180 to 300 before 10:30 or 11 a.m. and arc 60 to 180 after 1 or 1:30 p.m.) If sun is shining always see that lens is shaded from direct rays. In some cases this can be done wholly or partially by means of front door of camera but to insure no direct rays on lens it is best to shade front with hat while exposure is being made. Always use windshield to protect fan governor. Shield on increases speed about 25%. When camera is inverted fan speed is decreased about 25%. Light funnel exposes about 7degrees of film at one time, therefore to check speed time the swing from one end of scale to other when camera box is open and divide by 18; i.e. 126/7= 18.

4. SPECIAL ADJUSTMENTS

Both the focal length and the back focal length of all lenses used in these camera owned by the U. S. Forest Service have been determined by the U. S. Bureau of Standards and are shown on the name plates attached to the camera. Also the arced film guides in each case have been machined and mounted so that the radius from the center of the lens rotating shaft to the inner face of a film mounted on the arced guides coincides with the exact focal length of the lens used in each camera. To obtain a perfect focus the lens barrel should be screwed forward or back in its rotating collar mount, while held in its center position, until the shortest distance between rear face of lens at its center point and the inner face of a strip of film or similar material stretched between top and bottom guides coincides with the back focal length of the lens involved as given on name plate of camera. As soon as this setting has been obtained, the stop ring in rear of rotating collar should be screwed in until seated against rear face of lens barrel. (This helps to hold the lens setting and also serves as a stop or depth gauge to facilitate correct focusing if lens is ever removed for cleaning, or otherwise disturbed.) After seating the stop ring, a set screw located on side of rotating collar should be tightly set so as to prevent any shifting of lens position.

With some instruments depth gauges of proper length and as small celluloid disk with center hole for fitting into rear end of lens collar and holding one end of gauge have been provided. In the other cases, they must be provided as needed.

The lenses in all instruments have been carefully set, and there is little chance of their needing readjustment; however, if at any time it is necessary to remove the lens, two points which should be kept in mind are:

1. Be sure to loosen clamp screw in side of rotating collar.

2. Mark and watch setting of stop ring to see that it is not disturbed in connection with the removal or replacement of the lens.

Adjustment of Alidade Sight

When the alidade is mounted and the transit carefully leveled, the slot of the rear sight and the hair of the front sight should be absolutely perpendicular. Plumbness of the slot in rear sight can be tested by marking a point on the front hair and then sighting on a perpendicular object or plumb line and noting if there is any shift to right or left of marked point as one runs his eye up or down for full length of rear slot. There should not be any need for adjusting plumbness of rear sight and before doing so, one should make sure it has been properly assembled and mounted. If an adjustment is needed it can be made by filing slightly one of the two bearing shoes on rear end of alidade. Knowing the rear sight to be plumb, the plumbness of the vertical hair in front sight can be tested by simply sighting on a perpendicular object or plumb line and noting whether the hair does or does not coincide for its full length. The plumbness of this hair can be easily adjusted by shifting to right or left the small crossbar to which it is attached at its upper end.

To minimize possibility of errors from above causes, one should always use the lowest adjustment possible in sighting for direct readings.

Adjustment of Leveling Blocks

The pivotal center and the arced bearing surfaces the bottom faces of the camera are supposed to be machined so that they lie in two parallel planes. The three bronze leveling blocks, or seats for spirit level on the top face of the camera have been adjusted, so that they lie in a plane parallel to the bearing surfaces on the bottom face of the camera, and the three bronze blocks on the lower face of the camera have been adjusted so that they lie in a plan parallel to the bearing surfaces on the top face of the camera and intended for use only when it is necessary to use the camera in its inverted position. There is very little danger of these adjustments being disturbed but if any adjustment should be needed the most feasible method is to simply shim up the various blocks as needed with very thin sheets of tinfoil.

Determination of Need for Adjustment of Vertical Angle or Azimuth Scales

The vertical angle scales which register on both ends of each exposure were not properly cut on several of the earlier transits, due to a manufacturer's mistake, and hence are erroneous unless they have been replaced. However, this is of minor importance and can be disregarded since in actual practice we ordinarily utilize only the zero point or "Level Line" marker on these scales and actually take off or spot all of our vertical angle readings by means of the independent paper printed vertical angle scales. (Any errors that may exist in the camera scale can be roughly checked by matching one of the printed paper scales to the graduations which are printed on each end of the pictures, or a precise check of both the camera scale and the paper scale can be made by computing the natural tangent of say 20^{o} for a base equal to the exact focal length of the camera concerned and measuring off this distance on either of the scales.)

The need for an adjustment of the "Level Line" markers of the vertical angle scale becomes, apparent whenever one finds that there is a constant error in vertical angle readings taken from the pictures.

The need for an adjustment of the horizontal or azimuth scale in like manner becomes apparent whenever one finds that there is a constant error in azimuth readings taken from the pictures.

The best way to check both of these adjustments is to set up with a standard surveyor's transit over a tacked hub, measure and record the exact height of the transit telescope and then take and record a series of horizontal and vertical angles on sharply defined points or targets, which it will be possible to identify on photographs around a 120' arc. Then set up the Photorecording transit so that the camera lens is directly above the hub and at the same height as the transit telescope; then orient the camera the same as the surveyor's transit, photograph the 120º arc and compare readings taken from the picture with those taken with the transit.

Certain suggestions in connection with this test are as follows:

a. Orient the surveyor's transit on some sharply defined vertical target, assume that this is due north or 0º, and set the lower plate accordingly.

b. Take and record a series of some 12 or 15 azimuth and vertical angle readings around a 120º arc, which extends about 60º to each side of the orienting point. In other words, so as to cover an are for an assumed 300' to 60' Az.

c. All targets sighted should be at least several hundred yards away and with a clear-cut horizontal or vertical profile so as to be easily identified on subsequent photographs.

d. Try to pick out at least one clear-out azimuth target near the two extreme ends of the arc, preferably on or as near as possible to an even 10 degrees of azimuth.

e. In selecting targets for vertical angle, try to select at least three which are exactly level with the transit, one near the center of the arc and one near each extreme. Most of the other vertical angle targets selected should be not more than one or two degrees above, or below level. (This tends to avoid small errors which might result from a difference in rate of vertical expansion or contraction of paper in the photographic print and the paper scale.)

f. In setting up the Photo Survey transit, be sure that the camera lens is directly above the hub used for the transit set-up and at exactly the same height as was the transit telescope.

g. Mount the alidade in its center position, level the instrument very carefully in both directions, orient it on same target used for orienting the surveyor's transit and assumed to be 0º set the azimuth ring on 0º, set the azimuth numeral dial on 300 so as to number film from 300 to 60, recheck level adjustment, and then make exposure. (After exposure has been made, it might incidentally be of interest to take direct azimuth reading with the photo recording transit on the same targets previously sighted with the surveyors transit and compare results as a check on the former instrument as to accuracy for direct readings.

In taking check readings from graduated pictures for the purpose of making adjustments, the work must be done with great care and precision or there is danger of doing more harm than good.

Certain suggestions or warnings are as follows:

a. Use a good magnifying glass for setting scale and taking off readings.

b. Make sure that the "Level Line", as scratched on film or marked on print, is exactly straight, without any wobbles, and bisects exactly the level line markers at each end of print. (A deviation of only 1/100 of an inch in this line will-result in an error of approximately 6 minutes in vertical angles read.)

c. It is best to check the level line markers by targets known to be exactly level with camera lens, or in any event not more than two or three degrees above or below level for reasons previously mentioned.

d. In checking azimuth readings, be sure that the paper scale has been accurately cut on its aligning edge. (This cut must be absolutely straight and exactly bisect the 0^{o} mark of the small vernier provided at top and bottom of the scale sheet. A variation of 2/1000 of an inch will introduce an error of about 1 1/4 minutes.)

e. Don't shift scales on the basis of one or two readings. Make sure that there is no error in taking off the readings and that the same error is fairly constant in a considerable number of readings.

Adjustment of Vertical Angle Scales

The vertical angle scales located inside the camera at both extremes of the exposure field should be so adjusted that the "Level Line" marker or zero point of both scales and the focal center of the camera lens lie in a horizontal plane parallel to the plane of the three leveling blocks located on outer face of camera. The scales are held and clamped in place by two screws inside the camera, which pass through slotted apertures in the angle arm of the vertical scale. In case adjustments are needed, loosen these screws and raise or lower the scales as needed by means of the small give and take screws which make contact with the top and bottom edges of these scales and can be reached from outer face of camera. (In some cameras a capstan screw located inside the camera and contacting a notch cut into frame of scale is used for this purpose.) In both cases these screws have a 48 thread so that theoretically one full turn should result in a shift of about 12-1/3 minutes. There is no vernier provided for making this adjustment, and the usual practice is to cut off a narrow strip of the paper vertical angle scales and glue it to frame of camera so as to enable one to gauge any movement of scale by reference to a fine line scratched on it's adjoining edge.

In making any adjustment of these scales, one must keep in mind that images or registrations in the camera are always reversed. For example, in making adjustment for an obvious error as determined from a picture which was taken with the camera mounted in its normal position, one should first make sure, that the camera is sitting in this same position, then it follows, that an upward shift on the scales at the right, hand edge of the camera is actually resulting in a downward shift of this scale as it will appear on the left-hand edge of the printed picture.

In cases where it may be necessary to remove one of these scales for replacing or repairing the azimuth numeral tape, the vertical scale can usually be removed and replaced without disturbing its adjustment by proceeding as follows:

a. First make sure that the "give and take" screws passing through top and bottom of camera are in firm contact with ends of scale.

b. Loosen up on top screw but don't touch bottom screw which, if undisturbed, will preserve proper position for reassembly.

c. Remove from inside of camera the two screws which pass through slots in the angle arm of the vertical scale.

Adjustment of Anterior Azimuth Scales

The interior azimuth scales, located at both top and bottom-of camera are mounted on the flanges of arced segments which have been machined to a radius corresponding to the exact focal length of the particular lens used in each camera and are pivoted on the bearing posts of the lens collar, the centers of which lie in a vertical axis with the focal center of the lens. The flanged arcs are held and clamped in position by 3 or 4 round headed screws, passing through slot's which allow for shifting as needed.

In adjusting these scales, the object is to position the bottom scale so that it's center 10 degree graduation will line in the vertical plane established by the alidade sights and the focal center of the camera lens when the camera is mounted in its normal position, and the alidade set its center position, so that any object sighted, when the alidade is mounted in this position and the camera precisely leveled, will register on the negative in perfect vertical alignment with this center graduation mark.

The scale located at top of camera when in normal position is intended for use only when pictures are to be taken with the camera mounted in its inverted position. Hence this scale should be adjusted so that its center 10' graduation lies in the vertical plane established by the alidade sights and focal center of lens when the camera is mounted in its inverted position and the alidade in its new center position.

Necessity for adjustment of either of these scales can be very easily detected by simply noting whether objects on which the alidade sight is trained when exposures are made do or do not lie in perfect vertical alignment with the center 10' graduation mark as registered on top edge of picture.

The procedure for making adjustment is as follows:

1. First note carefully whether the error to be adjusted is occurring in pictures which have been taken with the camera mounted in its normal or in its inverted position. Then set the camera in same position as when picture was taken; i. e., normal or inverted, and the scale to be adjusted will be the one located on the bottom of the camera.

2. Now, if on the picture the printed azimuth scale needs to be shifted to the right to give correct readings on checked targets, the scale in the camera should be shifted to the left (due to reversal of images) or vice versa.
3. To shift the azimuth scale in the camera, loosen the 4 clamping screws and then turn slowly the large thrust screw which passes through the lug located on right edge of fan-like segment on which the scale is mounted. This screw has a 32-thread and one full turn should move the scale about 24 minutes. With the newer transits there is a vernier located on bottom and covered by a metal shield which must be removed. Also there is a heavy counter spring on opposite side of fan segment which keeps the thrust screw in contact, and so gives either a forward or back movement as screw is turned. With the older transits, there is no vernier or counter spring. In such cases, a crude scale can be made by cutting a small segment from one of the paper vertical angle scales, extending both ways from the zero point, and mounting it so that it will register against a scratch on the azimuth scale as adjustment is being made. Also, in the older cameras the end of the thrust screw must be kept in contact by applied pressure. In both cases the clamp screws should be tightened as soon as the desired shift has been made.

STEPS IN CAMERA OPERATION

For the inexperienced operator it is recommended that the following routine be followed to insure accuracy and uniformity in camera operations:

1. Select point for set-up and first 120 are to he photographed and unpack equipment (pg. 11, 23).
2. Assemble tripod (or screw tripod head to board for house and tower use) and set in position for arc selected for first photograph (pg. 11, 14).
3. Check film number in camera reloading if necessary and set camera on tripod head (pg. 11, 12, 14).
4. Determine filter, lens diaphragm opening and exposure time by use of Harrold Exposure scale (pg. 24, 25).
5. Attach filter and adjust diaphragm opening; attach proper exposure fan, housing, cable release and alidade, seating the latter properly (pg. 13, 14, 15).
6. Adjust azimuth tapes, the one on bottom of camera to agree with are to be photographed and the one on top of camera to read "Blank". If serial numbering is desired set exposure number tapes (pg. 12, 13).
7. Wind lens movement (Caution: Do not leave door open) and bring proper film in exposure position, using same winding key for both operations (pg. 11, 12, 13).
8. Level camera (and solar, if used) and orient according to methods discussed, making sure azimuth ring is clamped in position (pg. 14, 15).
9. Set camera on either the 300º, 60º, or 180º azimuth ring graduation, according to arc being photographed, and clamp in position if necessary to secure rigidity.
10. Check level and make exposure. Lens mechanism can be tripped by either cable release or button release (pg.25).
11. Without making any other adjustments, recheck camera level and orientation, and note and correct any angular discrepancies.
12. Wind lens movement, bring next film number into exposure position, adjust exposure number tapes (if serial numbering is desired), reset the camera to the 300º, 180º, or 60º graduation used on the first exposure, level instrument and make a second exposure of the same arc. On this exposure change either the exposure fan, lens opening or filter to insure at least one good negative in the two exposure taken (pg. 11, 12, 13).
13. Same as in step 11.
14. If a new set-up up necessary for next azimuth arc to be photographed (as on a lookout house or tower), follow procedure given in steps 4 to 12 inclusive.
15. If another 120º sector call be photographed from first camera set-up, wind lens movement, bring next film number into place, adjust azimuth and exposure number tapes, recheck Harrold Exposure scale values (making necessary changes in exposure adjustments), recheck orientation and swing camera to azimuth graduation desired (300º, 180º or 60º). Check level and make exposure.
16. Proceed as in steps 11 to 13 inclusive.

Large Fail	Med.	Small
2"	1"	1/2"

Note: - Above table applies for diaphragm openings F/16 to F/45. With larger diaphragm openings time of exposure increases slightly due to all increase in width of light band striking film. An F/6.8 stop opening gives a 40% increase in time.

Use of the narrow light funnel opening is recommended for distant views and most precise results.

Correct Time Factors for Various Filters
(Using Type 2 Panchromatic Areo Film)

Filter -	K_2	#12 Minus Blue	A	F
Color -	Light amber	Dark amber	Light red	Dark red
Multifactor -	2x	4 1/2x	8x	16X

-Notes-

Red filters most effective for cutting haze; "K_2" gives best color correction. For distant views "A" filter will usually give best results. Under perfectly clear conditions "K_2" and "A" will both give good results.

Refer to Harrold Exposure scale for all settings. Speed of above film rated as "D" on Harrold scale. As a general rule, use small diaphragm openings and large fans. For altitudes above 6000’ decrease exposure about one-half [stop].

-Cautions-

- Don't tamper with settings of lens or interior scales, as both have been precisely adjusted, the former to measurements made by U.S. Bureau of Standards. (Refer to detailed instructions when it is necessary to make adjustments oil any of these parts.)
- Avoid running lens motor without fan.
- Always use exposure fan housing on normal camera position.
- Stop winding motor when it clicks.
- In releasing motor, hold down release for a few seconds until stop pins clear.
- Lens has no shutter so do not wind motor with lens door open.
- Don't force leveling screws.
- Always see that alidade is properly seated and sights plumb.
- Remember, accuracy of results depends oil accuracy of orientation and level adjustments.
- In using alidade, sight through low point on rear sight.

-[Addendum Notes 9/15/49]-

Best test exposures: IR Film; F/64 @ 1 sec. fan – bright sun, August

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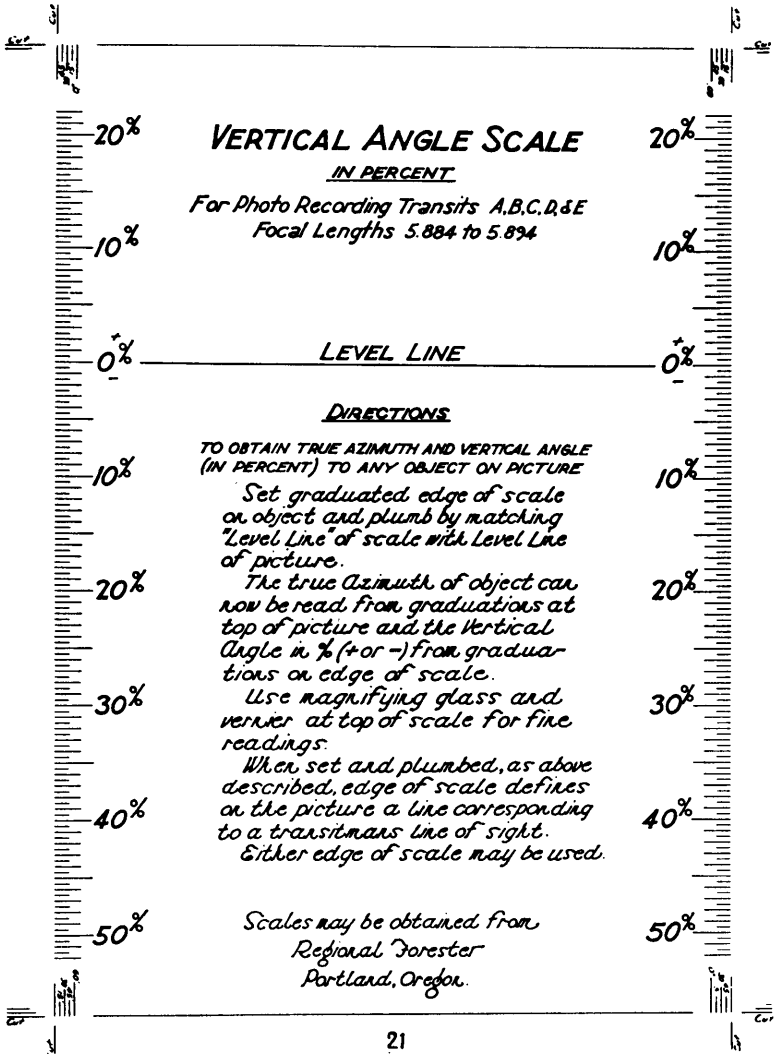

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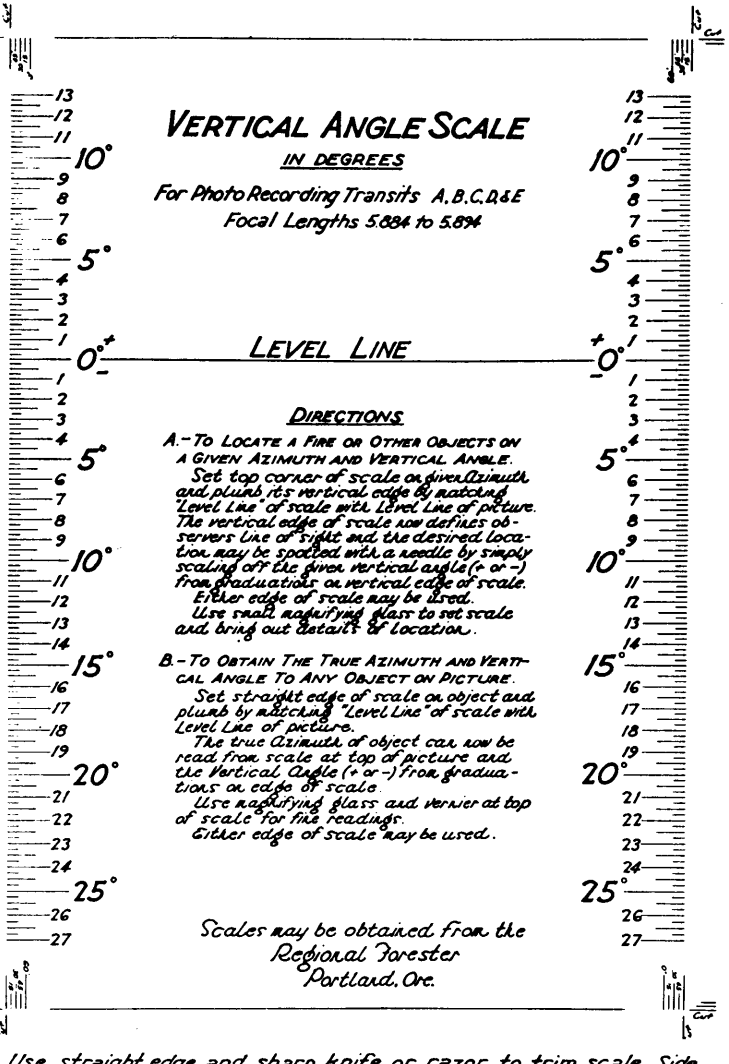
Use straight edge and sharp knife or razor to trim scale. Side cuts should split markers and must be straight and parallel. Ends should be cut back to match graduations of picture. Shrinkage of paper scale and pictures correspond. Over and under size scales are available if needed.



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