METHOD FOR TESTING PHOTOGRAPHIC QUALITY OF AERIAL NEGATIVES

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THE inspection of aerial photographic materials as executed by the Agricultural Adjustment Administration may be divided into two rather sharply divided classes of work, namely, the cartographic or engineering inspection involving crab, tilt, overlap, etc., as determined from contact prints, and the photographic inspection of the negatives to determine their acceptability for each particular contrast based on the Standard Government Specifications for Aerial Photography and the Invitation to Bidders.

Photographic inspection is a function of the centralized Aerial Photographic Laboratories. These are two in number, serving the eastern portion of the country from Washington, and the western portion from Salt Lake City. A preliminary part of the inspection may include generally all physical defects such as stains, abrasions, dirt and blemishes of any kind. To elaborate, the Washington Laboratory procedure for film inspection requires the notation of "chemical stains, blemishes, uneven spots, air bells, light or chemical fog, streaks, tears, holes, finger marks, dirt on the back or on the emulsion side of the film, emulsion peels, kinks, unexposed spots, heat buckles, exposure overlaps and unspliced sections." Of course there are many others, but these are mentioned as typical. Such deficiencies can easily be noted and application of a high degree of technical judgment is not so necessary.

However, in regard to the contrast range, tone value, and definition the inspector is faced with difficult problems. It is obvious that true contrast range or gamma value is directly related to the photographed terrain when all other elements are considered as controlled.

The Standard Government Specifications for Aerial Photography (approved November 18, 1939) read as follows: "Exposure and development shall be such as to yield negatives of high quality. The film shall be developed in a non-staining developer to a gamma or contrast which will yield negative showing clearly the demarkation of boundaries or fields, roads, woods, etc., when printed or enlarged on semi-matte surface photographic paper. The exposure of the negatives shall be such that printable detail is obtained in the thinnest part of each negative. The density of the thinnest parts of the negatives shall not be excessive, that is, negatives of medium density requiring moderate exposure time in making enlarged prints without the sacrifice of detail and contrast are desired. Very thin negatives or very dense negatives shall be rejected."

A study of this paragraph reveals a logical testing method; namely, the ability of the given negative to produce a satisfactory print. Any direct method of measuring the gamma value must hinge upon a preconceived tone value standard which, in aerial photography, is uncontrollable and, therefore, incompatible with true measurements. It is conceivable that with any constant reflection surface available an actual representation of the ground tone range could be observed. Even this would require controlled processing by the contractors and the Laboratory checking technique might be slow and cumbersome.

If a negative has such quality as to give a print which reveals property boundaries and culture identification with sufficient clarity, it is acceptable if the processing elements are logical and reasonable with reference to the equipment available to the purchaser.

From the beginning, the Laboratory has made test prints for the purpose of determining the acceptability of the aerial negatives. When any reasonable quality was produced in a print, the actual acceptance or rejection was the result of the technical judgment of the reviewer. This decision, while not so difficult to fix in a reviewer's mind, is of course hinged on the processing necessary to make the print.

The elements entering into the production of a test print for negative acceptance must be controlled, recorded, and made available for future reference. The Laboratory is a production organization making photogrammetric products of the maximum quality commensurate with existing standards. Time cannot be utilized to any but production purposes. When excessive manipulation is necessitated by inferior material, production falls and the cost schedules are upset.

When, during the course of the inspection of a roll of film, an inspector notes the presence of any definite discrepancy involving density or definition, he reviews the entire roll with this discrepancy in mind, noting changes in quality and those negatives which will, in his opinion, decide the acceptability of all or any part of the roll. Generally, the exposures picked represent the poorest condition and the best condition, if the discrepancy is on a gradient. These exposures are placed on a negative test printing order and submitted the following morning to a special dark room testing crew.

This dark room crew has been carefully trained in our technique of test projection and in order to secure coordination between the film inspection and test crew operations, a reviewer is present from the Film Inspection Sub-Unit, who is responsible for obtaining the results required in the course of the inspection and who dates and signs the negative testing data sheet.

The standard D-72 developer is used, at a dilution of one to four. The formula for this "universal" paper developer as given by Crabtree and Matthews in *Photographic Chemicals and Solutions* is strictly adhered to and is composed of the following:

Stock Solution	*Metric*	*Avoirdupois*
Water (about 125°F.)	500 cc.	16 oz.
Elon	3.1 grams	40 grains
Sodium Sulphite, desiccated	45.0 grams	1½ oz.
Hydroquinone	12.0 grams	175 grains
Sodium Carbonate, desiccated	67.5 grams	2¼ oz.
Potassium Bromide	1.9 grams	27 grains
Water to make	1.0 liter	32 oz.

The temperature of the developer is maintained as nearly as possible at 70° Fahrenheit. These thermometer readings are observed frequently during the course of a test run and particularly during the summer when it is necessary to add ice to the surrounding jacket water.

The square tube mercury vapor lamps are used as illumination standards in this Laboratory. This is necessary as there is a real need for a standardized type of light source inasmuch as a unit producing light of any other wave length combination would necessarily result in variable gamma value in the emulsion reaction. The actinic value of the mercury vapor square tube units as evaluated against their economy of operation, coolness, stability of light quantity, and their usability in the more rapid vertical projection cameras have made them adaptable to our purposes. The light quantity is checked on the surface of the projection easel at a one to one projection in each of the four corners and in the center. In order to properly orient the light readings with resultant prints, it is necessary to have the print numbers as applied by the projector to fall in a consistent position on the image and this is taken as the lower right hand corner as viewed by the projector on the easel

The nature of these mercury vapor lamps precludes the possibility of light intensity adjustments through variable resistance, etc., therefore, the intensity readings are maintained in units of foot candles and if the resultant reflection densities appear to be excessively high or low, the light intensities must be taken into account accordingly in relation to the exposure time.

At present, we maintain a minimum of .15 foot candle for test work. When any light falls below this quantity in any of the areas, it is immediately replaced.

The maximum aperture for the 12-inch focal length lens on the test camera is F:16, and when negatives appear to be on the thin side, this may be decreased to no less than F:32. With our lighting equipment it is considered impractical to dodge efficiently a print with any smaller quantity of projected light.

The same camera is used constantly for all testing work and any possible variants in inherent camera and lens structure, while not measurable and so not subject to analysis remain the same for all tests made in the laboratory.

The exposure time may vary between 10 seconds and one minute. Below 10 seconds, it is considered impossible to give adequate light dodging to secure even tone throughout the print area. When the exposure exceeds one minute, it is considered too long for normal production rates.

The exposure of any photographic medium is generally accepted as the product of the exposure time and the intensity of the light source, all other factors being constant. Therefore, the maximum exposure time of 1 minute is subject to change. An excessively intense light will of course reduce exposure time or increase it if the light intensity should fall. In order to standardize this element, the exposure time as discussed in this article is assumed to be in relation to a .20 foot candle light on the easel at a 1 to 1 projection, and the time must be corrected inversely to the percentage divergence of the light quantity from this figure when such a correction is pertinent. It is well known that actinic light values vary with the intensity but the above limits of restriction we now believe are sufficient to warrant no further control.

Within these exposure and aperture limits, we allow the use of four contrasts of a well known photographic enlarging paper. It is presumed that these paper contrasts and other reaction values are checked sufficiently by the vendor to produce comparable results. The four contrasts used include Normal, Medium, Contrast and Extra Contrast.

It is only through the use of a print produced entirely free of variable exposure and accelerations that true reflection values are obtained. Reflection values on a dodged print are subject to all the variables of individual skill and aptitude-elements that cannot be considered in absolute evaluation as far as the processing operation is concerned. Therefore, the first printing made from each negative involving density values is made once undodged by light or developer, then later printed by dodging both light and developer. As many prints are made by the dodging method as are necessary to produce the best possible print within these detailed standards.

When the noted discrepancy specifies sharpness, a standard test grid with considerable detail is projected at 2.5 diameters, F:16 aperture, making a white line black print, the fine lines of which must be clear and distinct. The test grid is oriented in the camera and identified in such a manner that the cameras are properly correlated to the test prints produced.

All test prints are projected at 2.5 diameters enlargement as this most nearly represents the normal production scale. All prints dodged or undodged, are given one minute, 30 seconds development. The fixing technique follows that prescribed by procedure in a fresh hypo fixing solution currently in use in the Laboratory. This varies somewhat as to the alum content, depending upon the season of the year, but this apparently has no effect on the reproducing properties of the negative. The washing time is forty minutes in free flowing water, after which the prints are dried in the regular manner and submitted for review.

All this information incident to the identification and production of the prints is entered on a prepared form which is later typed and attached to the produced print, a copy being filed with the inspection report in the Film Inspection office.

The completed form attached to the print noting the original discrepancy is available to the reviewer and is used fully in making the recommendation as to acceptance or rejection. The recommendation is entered on the form and the prints are filed in a permanent file. When the final decision regarding the acceptability of the material has been reached, the appropriate notation is also entered on the Negative Testing Data sheet and the history of the deficiency can now be reviewed at any subsequent date for suitable processing data or for substantiation of the decision reached.

These standards are not complete or final. They are simply those figures and methods now found to be the most logical and best suited to the needs of the Administration and the technical knowledge and equipment now available. They are not necessarily applicable to all possible deficiencies but the system has so far proved adequate, and when new inspection elements arise, we shall further revise, supplement, or modify this procedure. When better testing apparatus is available, due consideration will be given to its adoption.