PHOTOGRAPHIC QUALITY ASSURANCE in DIAGNOSTIC RADIOLOGY, NUCLEAR MEDICINE, and RADIATION THERAPY

Photographic Processing, Quality Assurance, and the Evaluation of Photographic Materials

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
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Photographic Processing, Quality Assurance, and the Evaluation of Photographic Materials

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FOREWORD

The Bureau of Radiological Health conducts a national program to limit man's exposure to ionizing and nonionizing radiations. To this end, the Bureau (1) develops criteria and recommends standards for safe limits of radiation exposure, (2) develops methods and techniques for controlling radiation exposure, (3) plans and conducts research to determine health effects of radiation exposure, (4) provides technical assistance to agencies responsible for radiological health control programs, and (5) conducts an electronic product radiation control program to protect the public health and safety.

The Bureau publishes its findings in appropriate scientific journals and technical report and note series prepared by Bureau divisions and offices. Under a memorandum of agreement between the World Health Organization and the Department of Health, Education, and Welfare, three WHO Collaborating Centers have been established within the Bureau of Radiological Health, FDA:

WHO Collaborating Center for Standardization of Protection Against Nonionizing Radiations (Office of the Bureau Director)

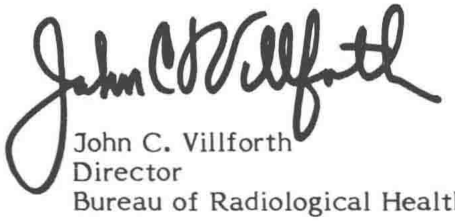
WHO Collaborating Center for Training and General Tasks in Radiation Medicine (Division of Training and Medical Applications)

WHO Collaborating Center for Nuclear Medicine (Division of Radioctive Materials and Nuclear Medicine)

As a WHO Collaborating Center, The Bureau makes available its technical reports and notes to participating WHO members.

Bureau publications provide an effective mechanism for disseminating results of intramural and contractor projects. The publications are distributed to State and local radiological health personnel, Bureau technical staff, Bureau advisory committee members, information services, industry, hospitals, laboratories, schools, the press, and other concerned individuals. These publications are for sale by the Government Printing Office and/or the National Technical Information Service.

Readers are encouraged to report errors or omissions to the Bureau. Your comments or requests for further information are also solicited.



John C. Villforth
Director
Bureau of Radiological Health

PREFACE

Production of radiographs with the best diagnostic quality and with the least radiation exposure to patients is a basic goal of the Bureau of Radiological Health. The efforts of the Division of Training and Medical Applications to meet this goal are diverse: one very promising approach is the development and promulgation of Quality Assurance (QA) information and methodology for diagnositic and radiology facilities. A Quality Assurance Recommendation is presently being developed for publication in the FEDERAL REGISTER. Concurrently, the Division is developing a series of quality assurance instruction manuals. These manuals will describe in detail the establishment and operation of specific elements of a quality assurance program for diagnostic radiology. They will present proven QA techniques which can be adapted by individual radiology facilities according to their needs and resources.

This manual, "Photographic Quality Assurance in Diagnostic Radiology, Nuclear Medicine, and Radiation Therapy," is the first in the series. It describes all aspects of a photographic quality assurance program for diagnostic radiology facilities. Although the specific procedures are based on the use of automatic processors, the overall plan of the QA program can easily be applied to manual processing. While Volume I of this manual described how to establish and maintain a quality assurance program, Volume II describes background and supplemental material. We hope this manual will encourage radiology facilities to adopt quality assurance procedures by providing the basis for a practical program.

We welcome comments on your experience with this manual, as well as suggestions for the content, style, and direction of the series.

William S. Properzio, Ph.D.
Acting Director
Division of Training and
Medical Applications

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CONTENTS

1. INTRODUCTION

The objective of Volume II," Photographic Processing, Quality Assurance and the Evaluation of Photographic Materials," is to provide the reader with additional useful information not covered in Volume I. To meet this objective, the problems and pitfalls normally encountered will be discussed briefly and references will be provided so that further, more detailed, information may be obtained.

Since many of the problems that we are faced with in radiographic film processing and the evaluation of radiographic materials in a radiology department are photographic in nature, the majority of the references are to photographic literature. Interpretation of the photographic literature in terms of radiographic applications is straightforward. For example, any literature dealing with processing of aerial reconnaissance films, or the interpretation of these films, will probably be applicable to radiology since the radiologist is a photointerpreter of sorts. Likewise, information concerning processing of motion picture film is usually applicable and may be of interest since the motion picture industry maintains some of the tightest standards for processing quality assurance in the photographic industry.

The annotated bibliography which is included in this volume provides references to various sources of information. This bibliography is not intended to be all-inclusive nor a critical review of the literature. It is intended to be a basic guide for the technologist who is interested in pursuing the problems he may encounter.

Commercially prepared literature is not included in this bibliography. This is not meant to slight the excellent material provided by many of the radiographic film and chemical manufacturers, but since this material is rapidly changing with the needs of the manufacturer and the user, it is difficult to provide an up-to-date listing of all of the available material. The manufacturers can supply you with a great deal of excellent literature concerning their products. You should not hesitate to request all of the pertinent information available concerning the products you are using.

Out of the vast literature available there are seven books that deserve special mention. These should be made available in your radiology department for direct reference by all technologists while others, being more advanced in their content, should be available through local libraries.

In terms of quality assurance, an excellent book has been published by the Society of Motion Picture and Television Engineers (SMPTE) entitled "Control Techniques in Film Processing" (Kisner et al., 1960). This is an excellent publication, written by Walter I. Kisner and 32 other individuals involved in processing and process quality assurance in an industry that must develop miles upon miles of photographic film each year, and do it repeatably from year-to-year as well as from day-to-day. This book goes through the basics of sensitometric quality assurance and also describes the chemistry of film processing as well as chemical analysis and control. However, do not let the latter topics intimidate you since the first portion of the book describes the procedures for sensitometric quality assurance in concise, explicit terms. This book is available directly from the SMPTE at 862 Scarsdale Avenue, Scarsdale, New York 10583.

As an introduction to basics and workings of photographic materials, one should obtain a copy of "Photography, Its Materials and Processes" (Neblette, 1962). Neblette provides an understandable introduction to all phases of photographic science with some references to the pertinent literature. This book covers such topics as filters, optics, cameras, photographic emulsion, theory of development, color development, sensitometry, xerography and much more. If you can purchase two books, these two are useful references.

"Photographic Sensitometry" (Todd and Zakia, 1969) specializes in the topics of processing and sensitometry with a section on processing and exposure effects and should be interesting reading for the technologist. One chapter discusses variability and process control but not in very great depth. Other topics such as film speed, spectral sensitivity, density measurement, and tone reproduction are included.

Moving on to more advanced texts, there are two books to choose from in the field of photographic theory: "Fundamentals of Photographic Theory" (James and Higgins, 1960) and "The Theory of the Photographic Process" (Mees and James, 1966). "Fundamentals of Photographic Theory," though a relatively old book, contains all of the basic information regarding the problems of photographic materials and film processing in a readable form. It covers many of the same topics as Neblette and Todd and Zakia but at a more advanced level. If you are interested in how things work, this is the book that can provide the information. A few basic references are given at the end of each chapter.

If you have read James and Higgins and are ready to tackle the big-time, then you should take a look at "The Theory of the Photographic Process" by Mees and James. Again, there is replication of material by this book with James and Higgins, Neblette, and Todd and Zakia, but this one starts where the others leave off. This text is used for many advanced college level courses and for some graduate courses. It covers the theory of the photographic process in detail. In addition to its rather all-inclusive content, it provides the reader with numerous references after each chapter (that are appropriately cited in the chapter). Each chapter contains between 20 and 300 individual references! One might refer to Mees and James as one large annotated bibliography except that the content of the book is more than sufficient to stand on its own.

The above books primarily discuss the photographic process from the photographic rather than the radiographic point of view. There is one particularly outstanding text that should be available in every radiology department, especially those with teaching and research programs. "The Photographic Action of Ionizing Radiations" (Herz, 1969) covers exactly what the title states. It describes all of the problems and processes normally encountered in the use of photographic materials with ionizing radiation. It starts with the basic production of electromagnetic and corpuscular radiation and proceeds to the absorption of photons and particles before discussing ionization measurements and units. The photographic process is covered by such topics as the preparation of an emulsion, sensitized materials, the basic principles of processing, and the mechanism of development. Next, Herz moves on to the direct photographic response to x rays and gamma rays including the fundamental aspects of the photographic action of x rays and gamma rays, quantitative considerations on spectral sensitivity, the influence of dose rate, the distribution of the latent image, graininess and granularity, directional effects, fading of the latent image and the influence of temperature on sensitivity. Equally extensive sections cover the photographic response to particles and photographic dosimetry. One chapter is devoted to each of the following topics: fundamentals of radiography (including image formation), medical radiography, processing of radiographs, industrial radiography, neutron radiography,

autoradiography, and microradiography. Herz also contains extensive references and bibliographies.

One final book which should be in every university library, engineering library, medical school library, photographic science library, and probably even in your department library is the "SPSE Handbook of Photographic Science and Engineering" (Thomas, 1973). This book was edited by W.T. Thomas, Jr., and is possibly the best 1416 pages of engineering information you can find. Since each section is written by top workers in the field, it provides the best and the most up-to-date information available. For example, you will find chapters on radiation sensitive systems, latent image formation, photographic chemistry, processing methods, material for the construction of photographic processing equipment, defect and contamination control, safety, sensitometry, densitometry, colorimetry, image structure and evaluation, testing and evaluation, photographic instrumentation, microphotography, holography.

One of the best chapters is the last chapter--a guide to photographic information. This section provides information on what photographic literature is available and where, taking over 60 pages to do it! The "Handbook," in general, supplies extensive references in each chapter. Where would you expect to find information on quality assurance, the life of fluorescent tubes, spectral transmission of safelight filters, calcium tungstate and barium lead sulfate intensifying screens, spectral sensitivity of various photographic materials, a cost study for automatic processing machines, sensitometry of x-ray film, photometric calibration, sensitometric processing, maintenance of densitometers, etc? Name it and you will probably find it in the "SPSE Handbook."

One other point should be mentioned before continuing with Volume II. In this volume various topics concerning film problems will be discussed. However, you must remember that the problems may or may not be associated with all films. They may or may not be associated with all brands of film or even all types of film made by one manufacturer. In addition, some of the problems are a function of the film-developer combination. In other words, if Brand A film exhibits certain "abnormal" characteristics with Brand B developer, this is no indication that it will exhibit the same characteristics with Brand C chemistry, or Brand A; then again, the "abnormal" characteristics may be present with all film-developer combinations but in varying degrees. The most positive statement you can make about the pathological characteristics of films and/or developers is that you cannot make any positive statements about their pathological characteristics.

The manufacturers of photographic films and chemistries strive to optimize their products for the conditions under which they are intended to be used. For example, since radiographic film is seldom, if ever, exposed at exposure times on the order of microseconds, and likewise tens of seconds, it is not optimized for use at these exposure times. If you anticipate using radiographic films at these exposure times, you may suspect the possibility of reciprocity law failure (see section 3). However, this normally only applies to radiographic films exposed to visible light (or ultraviolet radiation). If the films are exposed to x rays directly, then one would not (normally!) anticipate reciprocity law failure. Be suspect--do not bet on it until you have tested it.

In summary, you might say that the intent of Volume II is to direct you to the original source of the information, rather than try to predigest the information for you. Volume II will point out possible problems and pitfalls you <u>may</u> encounter and push you in the right direction--the rest is up to you. However, remember that the only thing you can say for sure is that you cannot be sure.

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2. SENSITOMETERS, DENSITOMETERS AND TESTING EQUIPMENT

2.1 SENSITOMETERS

2.2 DENSITOMETERS

2.3 ALUMINUM STEP WEDGES IN RADIOLOGY

2.4 RESOLUTION

2.5 SUMMARY

Any instrumentation used in the evaluation of radiographic films or other photographic materials must be selected and maintained with care. The inappropriate choice of a sensitometer may completely invalidate your comparison of two radiographic films. A test phantom used with incorrect geometry may produce erroneous results indicating that two screen-film combinations exhibit the same resolution when in fact they do not. Your work will be only as good as the tools you select and your techniques. You do not necessarily need the most expensive equipment to get the best results, but you must be aware of the problems associated with your equipment.

2.1 SENSITOMETERS

The different types of sensitometers were described in Volume I. For radiographic applications, only type 1 or type 2 should be considered since the type 3, the time modulated sensitometer, may introduce problems associated with reciprocity law failure. Sensitometers using visible light sources are the most convenient to use and are described extensively in the literature (Kisner, et al., 1960; Neblette, 1969; Thomas, 1973; Todd and Zakia, 1969). The calibration of sensitometers is discussed in Thomas (1973) but not in terms of modern screen-film systems.

In most cases the calibration of a sensitometer requires extensive and expensive photometric equipment seldom available to hospitals. Normally one purchases a sensitometer that has been calibrated by the manufacturer. By following his instructions it is possible to maintain the sensitometer in a reasonably calibrated condition; however, a sensitometer may be used without calibration as long as you are aware of the problems you may encounter.

If you know the spectral distribution of your light source, you can add the appropriate filtration to simulate the spectral emission of calcium tungstate screens. You do not have to know the absolute calibration, merely the relative calibration. This means that you probably cannot compare your results with results from another sensitometer, but you can have confidence in all of your results. For example, as long as you use the same source and filter, and maintain the same procedure, you could readily compare the results of films evaluated several months apart, assuming processing was maintained at the same level. With a relative calibrated sensitometer, it is preferred, when evaluating several different films, to expose and process the sensitometric strips at the same time to eliminate any possibility that the differences you see are due to changes in photographic processing, voltage differences, aging of the sensitometer sources, et cetera. Even if you have a calibrated

sensitometer, but do not have calibration facilities to check the calibration every 2 or 3 months, it is better to operate your sensitometer as a relative device. In addition, every sensitometer should be operated with adequate voltage regulation, which usually means that it will be necessary to use an external voltage regulator.

Difficulties will be encountered with the newer screen-film combinations since the spectral emission of the newer screens does not match that of the calcium tungstate screens. Since the new screens contain several emission lines, it is virtually impossible to match the output of the sensitometer to the new screens with presently available sources and filters. In this case the best approach is to use an x-ray sensitometer or a technique such as the one described in Volume I to compare different screen-film combinations.

Another problem to bear in mind is that with most visible light sensitometers you are exposing only one emulsion, whereas in normal use both emulsions of the film are exposed simultaneously. One sensitometer using electroluminescent panels does expose both emulsions simultaneously but, because of the emission characteristics of the panels, this device is suitable only for quality assurance and not for intercomparisons of radiographic films.

In most modern radiographic films the front and back emulsions have similar speed and contrast characteristics, but strictly speaking an exact comparison can be made only when both emulsions are exposed--simultaneously. If both exposures are not made simultaneously, you will probably encounter difficulties because of an intermittency effect which means that two exposures whose sum is equal to a single exposure will probably not produce the same result as the single exposure (James and Higgins, 1960; Mees and James, 1966; Neblette, 1962; Todd and Zakia, 1969).

The ideal approach would be to use an x-ray sensitometer with a technique similar to that normally used in clinical radiography. Several papers discuss x-ray sensitometers (Haus & Rossman, 1970; Kastner et al., 1969; McInnch, 1960), but these are cumbersome to use and costly to construct and calibrate. In particular, the device proposed by Kastner et al., (1969) would not be suitable with intensifying screens since it uses a time modulated principle that introduces reciprocity law failure (Herz, 1969; James and Higgins, 1960; Mees and James, 1966; Neblette, 1962; Todd and Zakia, 1969). This problem of reciprocity law failure arises only with photographic materials exposed to visible light or intensifying screens and not with materials exposed directly to high energy radiation, such as x rays and gamma rays (Herz, 1969; Mees and James, 1966). Consequently, the time modulated device would be satisfactory for evaluating films using direct x-ray exposure but not for evaluating screen-film systems. Other problems concerning the exposure technique, such as the use of an aluminum step wedge, must be considered and will be discussed below.

2.2 DENSITOMETERS

Densitometers do not have as many potential problems as are encountered with sensitometers. Densitometers are relatively easy to calibrate and with a few precautions and quality assurance checks on the densitometer, they will provide reasonably accurate measurements over extended periods of time.

In selecting a densitometer, it is important to choose one that will read densities in the range of interest. For quality assurance, a densitometer that can read a maximum of approximately 2.5 is adequate but it would be preferable to have a device that could read between 3.0 and 4.0 for evaluating radiographic films. If you are planning to use the device primarily for quality assurance,

and do not plan on reading very many densities at one time, the visual densitometers will probably suffice; however, if you are planning to plot several H&D curves for comparing different films, or if you are planning to make many readings, an electronic model would be desirable. If you are planning to use your densitometer extensively, then an additional investment in a digital readout would be worthwhile. The newer solid state models with digital readouts are not as vulnerable to drift and the reading is almost immediately available. In some models using meter readouts, the needle tends to drift before settling on the correct reading. It may be necessary to wait several seconds (up to 10 seconds in some cases) for this drift to stabilize before making each reading.

The major concern in selecting a densitometer with regard to its stability is the voltage stabilization. A densitometer must be operated on a voltage stabilized circuit, as must a sensitometer. The stabilizer may be built into the densitometer, but if one is not present as part of the circuitry, or if your line voltages tend to fluctuate considerably, you should add a voltage stabilizer between your densitometer and the power outlet. Some of the newer solid state densitometers include a feedback circuit that monitors the brightness of the source and compensates if there is any drift because of voltage fluctuations or aging of the lamp.

A densitometer used for radiographic work should have a visually-sensitive detector, i.e., the detector should have the same spectral sensitivity as the human eye. This makes sense since the final observer of the films that you are measuring will be the human visual system. Most densitometers are appropriately filtered to provide such response. In addition, it is not necessary to purchase the more expensive "status" colored filters normally offered for sale with densitometers unless you anticipate evaluating colored photographic materials. Your densitometer should also conform to the ANSI standard PH2.19-1959 and read "diffuse visual density."

Calibration of a densitometer is a relatively simple procedure usually outlined in the instruction manual supplied by the manufacturer. You will need a calibrated step wedge which should be supplied with your densitometer. If you wish to obtain additional calibrated wedges, these should be available through your local photographic supply house, but be sure to specify a calibrated step wedge with densities ranging up to 3.0 or greater.

For the appropriate quality assurance procedures, refer to Volume I. General information concerning densitometers is available in the literature including Herz (1969), James and Higgins (1960), Kisner et al., (1960), Neblette (1962), Thomas (1973), and Todd and Zakia (1969).

2.3 ALUMINUM STEP WEDGES IN RADIOLOGY

Aluminum step wedges are convenient to use and normally available in a radiology department. However, aluminum wedges present certain problems that must be taken into consideration in using them for the evaluation of radiographic materials. The aluminum step wedge was designed to provide incremental exposures to the screen-film combination, or directly to the film, by using increasing thicknesses of aluminum. Such a wedge would work quite well for monoenergetic radiation that produced no scatter in the aluminum. However, the normal x-ray distribution used in clinical radiography is not monoenergetic and the aluminum does produce scattered radiation. The increasing thickness of aluminum can be considered to function in two ways: (1) it attenuates the x-ray flux as the steps become thicker and (2) it also acts as a filter to the radiation hardening the beam as the wedge becomes thicker. Consequently, you do not have the same type of radiation exposing the screen-film combination, or raw film, at the thick end of the wedge as you do at the thin end. Likewise, since

film, at the thick end of the wedge as you do at the thin end. Likewise, since the spectral nature of the radiation is changing with the thickness of the aluminum steps, as well as the x-ray flux, you cannot easily determine the relative log exposure values needed to plot an H&D curve. This may be more obvious if you think of it in different terms. An aluminum step wedge exposed at 60 kVp and 80 kVp on the same type of film will produce two radiographs that are considerably different in appearance. The 60 kVp exposue will have considerably more contrast than the exposure at 80 kVp. This contrast difference, if not recognized as being due to the difference in technique, may be attributed to increased contrast of the x-ray film. This does not eliminate the use of the aluminum wedge in the evaluation of radiographic materials. It does, however, place some constraints on the efficacy of this procedure.

In order to plot the characteristic curve of various films it will be necessary to calibrate the aluminum step wedge for the specific kVp and for the specific x-ray generator being used. This technique is discussed by Seeman and Roth (1960 and 1962) and Corney and Seeman (1947). However, this places limitations on the use of the step wedge and is a time-consuming task. In order to avoid this calibration procedure, one may simply expose a normal aluminum step wedge at a fixed technique (and with only one x-ray generator). You may then plot a density versus Al thickness curve (see Volume I) and compare the films in this manner. This technique is valid as long as you compare films exposed at the same kVp, with the same aluminum wedge, on the same x-ray generator, and processed in the same photographic processor under identical conditions.

This raises a question concerning the determination of parameters such as contrast and speed of a film using the density versus Al thickness curve. You can use any technique, as long as you are consistent, which would normally be used for such measurements like the ANSI standard PH2.9-1974 entitled Method for the Sensitometry of Medical X-Ray Films and Dental X-Ray Films. However, you must bear in mind, and explicitly state in any reports, the exact techniques used and state that you are only using the contrast and speed measuring techniques and not the associated exposure and processing techniques. In plotting your density versus Al thickness curve you may think of a 3 mm step of aluminum producing a relative log exposure difference of approximately 0.15 at 80 kVp (using a three-phase generator which provides a HVL of approximately 2.5 mm of Al at 80 kVp).

2.4 RESOLUTION

The measurement of resolution of radiographic screen-film combinations is a procedure that may or may not provide you with useful information. In most cases the radiologist is attempting to detect low contrast objects that are a few millimeters in extent, such as lesions in the lung. In such instances the measurement of resolution is a meaningless exercise. The resolution figure you obtain applies to high contrast, fine detail structures such as fine vessels that have been completely filled with contrast material as in angiography. If you have access to low contrast resolution targets (targets of 0.010 mm of lead or 0.025 to 0.050 mm of pure copper) the results may be more meaningful for chest and general radiography. These targets, however, are not widely available at this time.

However, resolution measures made with 0.050 mm lead targets or targets constructed of tungsten-loaded copper may provide an indication of screen-film contact, the general imaging capabilities of a screen-film system, or the capabilities of an image intensifier if used properly. It is not necessary to measure the resolving capability of nonscreen films since their resolution far exceeds that of the x-ray phantoms presently available.

Since you are interested in measuring only the resolution of the screen-film system (or intensifier-film combination), then the resolution phantom, or target, should be placed in intimate contact with the front surface of the cassette (or image intensifier). The focal spot should be at least 1 meter away, with 2 meters preferred. The focal spot causes a considerable decrease in resolution as it is moved closer to the cassette and the phantom is moved away from the cassette. The exposure to the film should be such that a density of 1.0 above the base-plus-fog level of the film is obtained after processing. Since the quality, or resolution, of photographic images depends on the exposure, all films should be exposed to the same density above the base-plus-fog level. Further information concerning the effect of film density on image quality may be found in Barrows (1957), deBen (1962), DeBelder et al., (1971) and Scott and Rosenau (1961).

If the resolution phantom is imaged in intimate contact with the cassette, and the focal spot is 2 meters away, the resolution should be relatively constant over the x-ray field; however, this is not the case if the focal spot is moved closer to the cassette and the phantom is moved away from the cassette, nor is it the case if there is poor screen-film contact. (For checking screen film contact, refer to Volume I.) In order to avoid any possible difficulties, all of your x-ray resolution images should be produced with the phantom centered under the central beam of the x-ray tube and in intimate contact with the cassette.

If you are evaluating the resolution capabilities of an intensifier-film combination, then you may anticipate quite different results. The resolution of the intensifier varies considerably over the input face of the intensifier and may change by 50 percent or more from the center of the tube to the periphery. In addition, the orientation of the bars of the resolution phantom may have an effect because of the aberrations of the image intensifier. This should be checked along with the variation of resolution with the field position of the phantom. Do not be surprised if the resolution is different at the center for two orientations of the test pattern and the same at the periphery. It is also possible to have one orientation of the test pattern give better resolution in the center of the image intensifier input and poorer resolution in the periphery than another orientation. All tests of image intensifier-film combinations should be made with the phantom as close to the input phosphor as possible and with the x-ray tube at least 2 meters away unless grids are used with the intensifier. In the latter case, you must use the distance specified for the grid or remove the grid for the tests.

2.5 SUMMARY

Select your instrumentation with care and use voltage regulators for sensitometers and densitometers. Maintain quality assurance checks on your instruments (see Volume I). If you are comparing the sensitometric characteristics of radiographic films, be sure to match the spectral distribution of your source and the exposure time to that normally used in clinical radiography--this applies to both visible light and x-ray sensitometers! The densities should be read from your films using a densitometer which reads visual diffuse density.

If you anticipate using an aluminum wedge for your sensitometric evaluation, it will be necessary to calibrate the wedge to a particular kVp on a particular x-ray generator. Otherwise, it will be necessary to plot density versus aluminum thickness in place of the standard H&D, or characteristic, curve of the film. This latter technique is perfectly adequate as long as you specify in all reports the exact procedures used and you do not try to extrapolate the results for other techniques, et cetera.

It may or may not be worthwhile to measure resolution. Low contrast resolution phantoms, or targets, will provide more useful clinical information than 0.050 mm high contrast lead phantoms (or tungsten-loaded copper), but these are not widely available at present. The geometry used to image the phantom is exceedingly important. With some image forming systems (e.g., intensifiers) the resolution may be found to vary considerably as a function of position in the image plane.

If you are testing new systems, compare your results to systems that you know are functioning properly. Be exceedingly cautious and question any results that do not make sense.

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