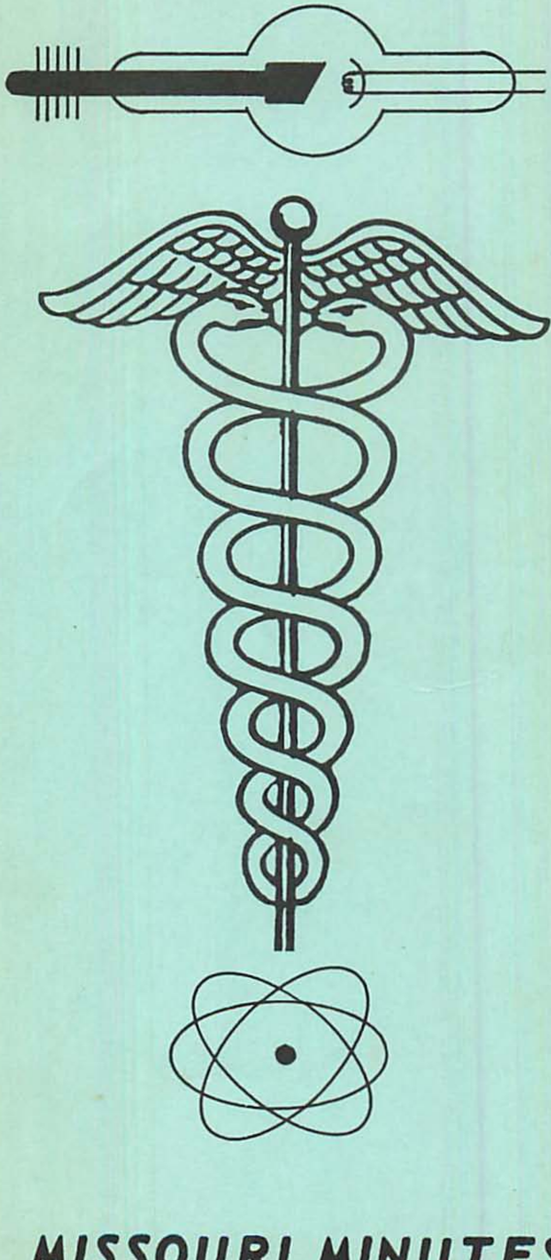
FEB 72



MISSOURI MINUTES

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"Opinions expressed in this journal are those of the writers and do not reflect offical opinions of the Missouri Society of Radiologic Technologists unless so stated. Originial articles are accepted only with the understanding that they are contributed solely to the "Missouri Minutes". If and when the manuscript is published, it will become the sole property of the Journal."

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FEBRUARY 1972

EDITORIAL

A popular subject of discussion today among educators in radiologic technology is one of "how to enhance the quality of education in radiologic technology without expanding the length of the program beyond its present two year duration." The answer to this problem seems simple enough to most people because the typical reply is "intensify the didactic instruction presently in use". Unfortunately, because the answer is so profoundly simple and obvious, the discussion generally ends with nothing more being said.

Few people seem determined enough or interested enough to make actual recommendations as to just how such intensification of instruction can be accomplished.

A recent letter sent to the Education Committee appointed to review the curriculum as outlined in the Syllabus, however, would indicate that there are people interested enough to say not only "something must be done" but to stipulate precisely just how the achievement of an upgraded educational standard can be accomplished. What is to follow in this editorial therefore, is an excerpt from this letter to the committee in which is cited one of the ways that the quality of education in radiologic technology can be upgraded without increasing the length of the 24 month program.

"..The Handbook of Anatomy and Physiology for X-ray Technicians by Mallett does not provide the student with a comprehensive enough study of the science of anatomy and physiology. Despite the title of the text, this book is amazingly deficient in the area of physiology. As a result, the student completes the course having acquired a very superficial knowledge of anatomy and almost no knowledge at all of the physiologic concepts governing the organs he must x-ray. The deficiencies of knowledge that the student has after having taken a course using the Mallett book manifests itself almost immediately in the inability of the radiologist to accurately communicate with the student in this area. Furthermore, it is an observable fact that any of the technologists who are considered expert by those capable of making that judgement have only achieved this expertise because they have read and studied additional anatomy and physiology books in order to fill in all of the "gaps" which characterize the Mallett book. Let it be clear that the recommendation made here is not one of having the student technologist study anatomy to the extent that a physician does, but merely to increase the level of proficiency and understanding of the subject by upgrading the existing standards under which anatomy and physiology is being taught in many places.

Although there are many fine textbooks of anatomy and physiology, there is one which, because of its excellence, I can recommend most highly. It is called Structure and Function in Man by Jacob and Francone.

I have had the opportunity to review this book in great depth and have found it to contain the type of material needed by the radiologic technologist if he is to achieve a level of competency consistent with his role in the health care delivery team. I am certain that if this book, or one which is similar, were to be used in the training of our technologists, not only would the patients benefit because of the additional knowledge gleaned by the student technologist in studying such a book, but the student technologists themselves would be forever grateful to their instructors for providing them with the kind of educational quality they sought when they enrolled in our technology programs ---

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Program News
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For further information:
Robert L. Coyle
AC 312-944-3410

The American Society of Radiologic Technologists announces the dates of six continuing education conferences for radiologic technologists to be held in 1972.

Robert L. Coyle, R. T., ASRT Director of Education, reports the conferences -- three in education and three in management -- will offer 11 to 12 hours of instruction by a well qualified faculty.

CURRICULUM DESIGN AND EVALUATION will be offered February 5, 6 in San Francisco at the Jack Tar Hotel; May 13, 14 in Philadelphia at the Marriott Motor Hotel, and September 22, 23 in Chicago at the Marriott Motor Hotel. Victor M. Coury, Ed. D., of the University of Tennessee will be the instructor.

HUMAN BEHAVIOR IN MANAGEMENT will be offered February 26, 27 in San Francisco at the Jack Tar Hotel; May 27, 28 in Philadelphia at the Marriott Motor Hotel, and September 22, 23 in Chicago at the Marriott Motor Hotel. Bill Hodge, Ph. D., Professor of Management at the Florida State University will be the instructor.

Each conference is limited to 100 participants. The fee is $55 for ASRT members and $80 for non-members. Conference registration and hotel reservation forms are available from the ASRT, 645 North Michigan Avenue, Suite 620, Chicago, Illinois 60611.

AFFILIATE SOCIETY ASSOCIATE CATEGORY REVIEWED BY BOARD

As reported in the October, 1971 issue of this publication, at the 1971 Annual Meeting of the American Society of Radiologic Technologists held in New Orleans, the Board of Directors was instructed by the membership to seek further legal counsel and report back to the membership their interpretation of Chapter V, Section 4 of the current affiliate society Bylaws, which section reads as follows:

"Associate members shall be those persons interested in radiologic technology but not having the qualifications for active membership. They shall have all the privileges and obligations of members except the right to vote or hold office."

After reviewing all the legal opinions, the Board of Directors unanimously reaffirms its previous interpretation of Chapter 5, Section 4 of the affiliate society Bylaws and, in agreement with legal counsel, rules that technologist members with the qualifications for active membership - namely those who are certified by the ARRT - must be active members of the affiliated society and are not eligible for associate membership.

Affiliate societies may recognize the associate membership of those R.T.'s now incorrectly classified as associate members until the next fiscal year of the respective society - at which time the aforementioned ruling takes effect.

XERORADIOGRAPHY

Jane Lynn Schroeder
Radiology Student
Forest Park Community College

During a disaster, such as an atomic explosion, one considers the questions involved in film processing such as: 1) the difficulties in providing and maintaining the sufficient stockpiles needed, 2) the necessity of protecting the above stockpiles from radiation during both storage and transfer to the point of use and, 3) the provisions of darkroom facilities, chemicals and water. These inherent difficulties for civil defense roentgenography are apparent at once when one remembers that the radiation energy of an atomic explosion is extremely destructive to the photosensitive emulsion of any type of film. One might consider the use of fluoroscopy alone and this completely eliminates the x-ray film and darkroom problems. This, however, seems out of the question for several reasons: 1) The human eye is subject to limitations thus diagnosis be impaired, 2) pathological changes seen on an x-ray may be invisible on fluoroscopy and, 3) some method of x-ray image recording would be necessary.

Discovery of Xeroradiography

In the fall of 1952, a process known as xerography was invented. Xerography is totally different from conventional film recording, since it involves no chemical process - no solution of any sort is used and thereby derives its name from the Greek word Xeros meaning dry. Therefore, xeroradiography may be defined as a process or method of producing roentgenograms without the use of conventional x-ray film and its wet processing. It offers a simple, safe and inexpensive medium for the recording of roentgen images with no darkrooms. There is no film deterioration problem. No special skill is required, and the same roentgen ray machine needed for conventional roentgenography can be used in xeroradiography without any modifications.

The Use of the Xerographic Plate

The xerographic plate, which is the vital factor in the entire process, consists of a sheet of metal with a thin layer of selenium fused on one surface. This base plate serves a dual purpose, whereby, it provides mechanical support for the photoconductive selenium and at the same time acts as an electrical reservoir into which an electric charge may flow. To give mechanical protection to the plate and to enclose the selenium surface in a light-tight container, it is encased within a wooden frame and a metallic cover slide constructed along the lines of the film holder.

Charging the Xerographic Plate

To use the xerographic plate, a charge of 6,000 volts is placed on the surface by passing a group of wires over the surface of the plate. The arrangement of wires are such that the positive ions produced in the air are repelled by the wires and flow onto the surface of the selenium where they deposit their charge. If the plate is protected from radiation, its charge will remain for a period of several hours with slight decay since selenium is an excellent insulator. If the plate is radiated those particles of selenium that are struck by the radiation become conductive and the positive charges that they held on their surface are conducted through the selenium to the metallic base plate. It is readily seen that if an object is placed between the charged plate and the x-ray tube, some of the x-rays will be absorbed by the object in accordance with its size, shape and density. The energy that passes through the object will hit the selenium and displace its charge in accordance with the disposition and intensity pattern of the x-rays. It follows then, that at the completion of the x-ray exposure, a portion of the original charge will be in the form of an electric image representative of the size, shape and varying radio-density of the object.

The electrical image becomes visible when the surface is sprayed with fine, powder granules - calcium carbonate - which are contrasting in color to the black selenium background. This is done by inserting the plate in a cloud chamber, removing the cover slide, and spraying the white powder under pressure into the chamber. During the spraying process, the powder particles are electrically charged so that they have a charge opposite to that of the selenium. The result is that the negative powder particles are attracted to and held by the positive charges on the plate. The pigment settles on the plate in proportion to the surface charge. At the completion of the spraying process, one has an etching-like image in black and white. This looks like a conventional radiogram from which one can make radiological diagnosis.

Making a Permanent Image

After the xerographic plate has been viewed on a special view box in which the illumination source is such that the light travels across the surface of the plate lending brilliance to the white powder on the black surface of the plate, can one make a permanent record by transferring the powdered image to paper by means of either an adhesive or an electrostatic technique.

Cleaning the Xerographic Plate

The image on the plate is removed by brushing the plate with a rabbit fur brush that removes any powder. A rabbit fur brush is used so as not to scratch the surface of the plate. The plate may be washed when not in use by removing the plate from its holder and swabbing it gently with a 1% solution of detergent on a photographic sponge. The plate is then ready for another cycle of charging, exposing, powdering, viewing, and brushing.

Xeroradiographic plates being capable of continued reuse and erasure, present a feature of "blackboard radiography" so to speak. This would be of considerable help in radiologic research and investigation. In research work, a few dozen plates will do the work of several thousand dollars worth of x-ray film which has a definite life. If one uses ordinary care, this procedure can be repeated hundreds of times. Attempts were made to wear out a plate, but were discontinued after 2,300 exposures.

Rapidity of Process

It is worth noting that the xeroradiographic process, in addition to the features mentioned above, is a very rapid procedure. It requires a total of 10 seconds to charge a plate and only 20 seconds to powder it. It is then easily possible to prepare a plate for exposure, expose it and have the finished image for interpretation in less than 50 seconds. Since there is no darkroom necessary, the complete processing unit may be set-up and operated in about 48 square feet of floor space. A unit can be set-up on a hospital stretcher and freely moved about from room to room making it a highly portable mobile unit.

Speed of Xerographic Plates

At the present time, these plates have a radiographic speed comparable to Kodak A x-ray film, and as such are not suitable for the heavy parts, such as the spine and abdomen. They are not as susceptible to secondary radiation as is film with intensifying screens, largely because of the filtering action of the metallic backing.

Precautions Against Fogging

Precautions must be taken to prevent fogging. For instance, it must be encased in a light-tight cassette when removed from the storage unit. Exposure to the light, secondary radiation or scatter x-radiation, to gamma or beta rays, or to nuclear radiation will fog the image.

Advantages of Xeroradiography

Xeroradiography - the technique of using photoconductors and electrostatic charges as a method of recording x-ray images - of the peripheral parts of the body has certain distinct advantages over conventional film technique. It is not perfect, and there are some disadvantages, but none are serious, nor do they detract significantly from the efficiency of the method.

From observations the following have been found advantages of xeroradiography:

a) More information is obtainable from a single xeroradiograph than from a comparable film image.
b) Differences in density, such as fracture lines or soft tissue calcifications, are accentuated within the structures being examined.
c) The technique has a great latitude of exposure factors, especially at low milliamperage and high kilovoltage.

Among the outstanding characteristics of xeroradiography is the extremely wide latitude of contrast available, due to the fact that the plate is black with a highly polished surface. The powder is snow-white, giving the image extreme elements of contrast, hence an outstanding visibility of detail or "see-ability" which is one of the fundamental qualities of a radiograph. Secondly, the film of powder is microscopically thin and, being on the surface of the plate, there is no "spreading out" of the images edges such as in the case of x-ray film with its relatively thick emulsion on both sides of the base.

Due to these characteristics, there is a sharp line of demarcation between tissue densities. As a result, more detail is visible than we are used to seeing on a film radiograph.

The fine definition and contrast graduation is greater in the xeroroentgenogram than in the conventional roentgenogram in studies of both bone and soft tissue. Much of the contrast graduation is enhanced by a slight exaggeration of sharp margins due to a slight increase of powder on one side and a slight decrease on the other side of the boundary of the electrostatic charge on the xeroplate.

Xeromammography

There are major differences and certain specific characteristics which make xerography especially suitable for mammography. The most significant difference is that although the overall image is one of low contrast, very small variations in radiation absorption can be observed. Another characteristic which distinguishes xerography from conventional radiography is the large differences in exposure do not result in great differences in the amount of powder deposited. Thus, over- or under-exposure is less likely to produce a nondiagnostic plate.

The combination of high contrast at the edges of tissues of differing density, combined with low overall contrast is illustrated in a xeroradiographic mammography film. One can see sharp detail from the skin surface up to and including the chest wall, all easily visible on the same plate.

Advantages of Xeromammography

Xerograms of the breast have the following advantages over film mammograms: a) They are easier to interpret, b) they require less radiation to produce than Kodak "M" film mammograms, c) they afford greater detail, d) they are probably more accurate, e) xerography is a dry process and, f) the finished product is obtained more quickly and with greater ease.

The most important factor is that they are easier to interpret. Properly set up, xerograms could probably be read in a screening program at the rate of 4-5 cases per minute, whereas, in a similar program film mammograms were read at the rate of 15-20 cases per hour.

Technique Xeromammography

The best xerograms are obtained with low kilovoltage, high MAS, and slow developing. The beam should not be filtered any more than is unavoidable either before or after striking the breast. Twenty-four to 32 kilovolts and 600 MAS at 32 inches, produce an image of good quality.

Difficulties of Xeromammography

From observations the following have been found to be technical difficulties in xeromammography:

1) Damage to the xerographic plates during handling is likely to occur with present techniques because the plates have to be manipulated a considerable number of times during processing. The surface of the selenium is readily scratched, which will leave a permanent artifact.

2) Humidity and clumping of the developing powder was a problem, but was solved by the use of an air compressor.

3) A loss of contrast occurs if the developing unit ac-

cumulates a considerable amount of used developing powder, and it must be cleaned after about 10 hours of operation. This powder is reusable.

Conclusion

Its use in medical radiography has been limited, however, because when used a direct substitute for photographic emulsion, its relatively slow speed (about one-half that of non-screen film) has been a major disadvantage. To increase the speed of the selenium plates is technically possible and it is expected that faster plates will become available.

During the course of the clinical investigation in this process, sufficient evidence has been gathered to make it safe to assume that many applications to general hospital radiography will evolve and the radiologist will have one more aid to diagnosis.

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LICENSURE NEWS

A bill designed to license the operators of x-ray equipment in the State of Missouri was reintroduced into the Missouri State Legislature on December 17, 1971. This bill, entitled House Bill Number 1294, is an exact replica of House Bill Number 317 which was first introduced by the Chiropractors of Missouri during last year's legislative session. Although 1294 was introduced by Representative Mulvaney, (last year's Bill 317 was introduced by Representative Heckemeyer), the sponsoring group is once again the Chiropractors of the State of Missouri.

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SEMINAR FOR CONTINUING EDUCATION

On April 14 and 15, 1972, the Missouri Society of Radiologic Technologists will be sponsoring the Second Annual Seminar for Continuing Education. Once again the University of Missouri will be hosting the Seminar in their facilities located in Columbia, Missouri.

The program itself (see listing further on in this article) promises to be even a bigger success than last year's and since enrollment was very high last year, those wishing to attend in April should enroll early in order to insure admittance to the Seminar.

This year's registration fee has been set at $25 which includes the cost of the two day Seminar, two luncheons and dinner. All of the remaining functions will be complimentary for those registered at the Seminar.

The program for Friday, April 14 will include the following:

"Communication - The Key to Interpersonnel Relationships":

The instructor for this discussion will be Vito Tamboli, B. S. who is presently the Director of Personnel Services for the Sisters of Saint Mary Motherhouse in St. Louis, Missouri. Those who attended the State Convention held in Fenton, Missouri this past year will remember Mr. Tamboli as the "dynamic" instructor who was, because of a shortage of available time, forced to cut his discussion short, much to the disappointment of his audience. It is a pleasure to know that Mr. Tamboli, having been wisely scheduled first on the program, will be able to share an entire instruction period with us this year.

"Designing and Evaluating a Learning Experience Based on a Proper Objective":

This most important aspect of technology education will be delivered by Mr. Leonard F. Boos, Marketing Educating Specialist for the Eastman Kodak Company.

"Circuitry":

Instructor to be announced.

The program for Saturday, April 15 will include the following:

"X-ray Tubes":

Mr. Gene Stober of Machlett Laboratories Incorporated will be the instructor for this portion of the Seminar. Mr. Stober is presently employed as a Sales Engineer in the X-ray Tubes and Special Products Division of Machlett, Incorporated.

"Socio-economics and Legislation in Radiologic Technology":

Being one of the "hottest" topics of discussion lately among radiologic technologists, this portion of the program will be conducted by Mr. George Meade and Mr. Robert Best, both of whom are in positions to be "right on top" of these controversial matters. As you know, Robert C. Best is currently the Executive Director of the American Society of Radiologic Technologists, while George Meade is the ASRT's Washington representative.

Together, these gentlemen should be able to cast some needed light on the Socioeconomic and Legislative issues confronting technology today.

Guarantee your attendance at the Seminar by ENROLLING EARLY.

REGIONAL DIRECTORSHIP CANDIDATES for region #5 will be meeting on Friday evening, April 14 to provide an opportunity for the radiologic technologists in Region 5 to become familiar with each of the candidate's credentials. The program will be arranged so that each candidate will be given a brief time period in which to address the membership and discuss his own personal qualifications for the position of Regional Director #5.

The following technologists have been elected by their respective states to run for the regional directorship:

Ernest Stoppelmoor, R.T.	Iowa
Ulysses Murray, R.T.	Missouri
John Sonnenfield, R.T.	Nebraska
Fred Price, R.T.	Arkansas

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DISTRICT NEWS

FOURTH DISTRICT

The Board of Directors of the 4th District, MSRT have announced that a membership drive will be undertaken by the district members beginning January, 17,1972. In order to generate enthusiasm for the "drive" a cash prize of $50 will be awarded to the member who enlists the most new members into the Society. The prize money is to be presented at the district's May meeting.

FIFTH DISTRICT

The November meeting of the 5th District was somewhat unique in that it was held in the US Medical Center for Federal Prisoners in Springfield, Mo. The program which was presented at the meeting centered around a description of a new type of prison: one which is characterized by no gun tower or fences. Although "thought provoking", said one of the members at the meeting, "it would make me kind of nervous to live nearby one of these types of prisons".

(Ed. comment: Me Too.)

The December meeting of the 5th District was held in the Radiation Therapy Department in Springfield, and Dr. Jose M. Sala, the guest speaker, discussed the founding of the Radiation Center and its purpose and intended plans for the patients it will service.

REGISTRY NEWS

Below is a chart taken from the November, 1971 issue of Radiologic Technology. The purpose of this chart is to show the percentage of questions found in the national Registry Test relating to the different subject areas. It is disconcerting, however, to note that in the areas of Special Procedures and Darkroom, an identical percentage of the test is devoted to questions relating to each of these areas. It is a well known fact that the area of special procedure radiography has been expanding rapidly over the last decade, while conversely, the technologists involvement with darkroom procedures has, because of automation, diminished considerably over the same period of time. Would it not be more equitable to expand the section relating to special procedures to 10% while reducing the darkroom section percentage to 5% in order to meet the requirements of modern day technology?

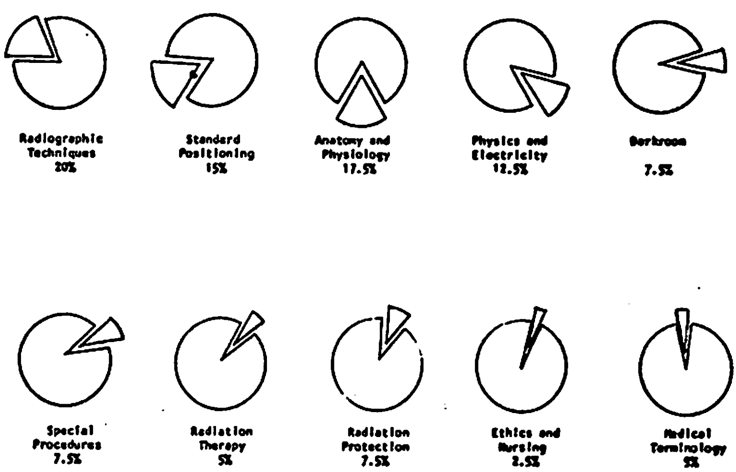

Fig. 1. Per cent of examinations in x-ray technology allocated to different categories.

TO: District Presidents

FROM: Board of Directors - Missouri Society of Radiologic Technologists

SUBJECT: Election of a district representative to serve on the Board of Directors of The Missouri Society of Radiologic Technologists.

At the 1971 meeting of the Missouri Society of Radiologic Technologists the members voted to increase the Board of Directors to include the following:

1. President
2. Vice-President
3. Secretary
4. Treasurer
5. A duly elected qualified representative from each district. This representative must:

a. Be an active member of the American Society of Radiologic Technologists, The Missouri Society of Radiologic Technologists, and the district in which he is elected.

b. Be elected by active members of the Missouri Society of Radiologic Technologists who also are active members of the district.

c. Be installed in office at the annual meeting.

d. Not concurrently hold an elective office in the Missouri Society of Radiologic Technologists.

The name of the elected director must be forwarded to the Secretary of the Missouri Society of Radiologic Technologists no later than July 1,1972.

The change in membership of the Board of Directors is by authority granted in Chapter X, Section 1, Item (b) of the By-Laws for Societies Affiliated with the American Society of Radiologic Technologists which reads:

> "Additional directorships may be established by a vote of the active members of the Society. Such directors shall serve for a period of one year and shall not succeed to the chairmanship."

If there are any questions please feel free to write me.

Very truly yours,

Richard S. Hammer, R.T.
Chairman, Board of Directors
Missouri Society of Radiologic Technologists

RADIATION HEALTH AND SAFETY ACT "S-426"

Dear Member:

As a member of the committee on Legislative Activities, I attended a district society meeting to discuss the Radiation Health and Safety Act of 1971. This proposal was introduced by Senator Randolph on January 28,1971 and it is titled "S-426". No one could discuss it with me. They were not aware of its content and possible effect.

This proposal is germane to radiologic technologists and is in committee as assigned by the national senate, but enthusiasm is apparently lacking as evidenced in the fact that only a relative few members even have a copy. You can get your copy by writing Senator Eagleton. Unless the membership is informed, gives direction and support to this committee it is impossible for us to represent you.

We are making a plea to be informed of your wishes as to this proposal. We will follow your direction and a summary of your collective responses to this appeal will be submitted to your editor for publication.

Sincerely,

F. V. Martin, R. T.
Member
Legislative Activities Committee

TECHNICAL TALK

An x-ray tube, as we all know, consists of an evacuated glass envelope containing a small tungsten filament (cathode) which, when heated by the passage of electricity through it, begins to boil off electrons.

These electrons are then attracted to a positively charged target (anode) which is also made of tungsten, and as a result of the interaction of these high speed electrons with the tungsten anode, x-rays are generated from the surface of the target.

The basic design and physics principles employed in the construction of an x-ray tube are well known to all radiologic technologists, however, there is more to know about an x-ray tube than just how it works -- we should also know the reasons why it sometimes doesn't work. By understanding what happens when a tube malfunctions it should become possible for the technologist to avoid situations which might be conducive to the ultimate breakdown of the tube.

To begin with it should be noted that the principle component parts of an x-ray tube, namely the filament, anode disk, and the bearings upon which the anode rotates, are each subject to nominal wear under normal conditions. On the other hand these normally durable components become extremely vulnerable to failure when exposed to certain undesirable conditions as a result of the misuse or abuse of the x-ray tube.

The results of overload conditions impressed upon an x-ray tube range from the minimum of slight pitting and surface cracking ("tracking") of the anode to the maximum of cracking or chipping the anode disk so severely that it breaks up into pieces. To avoid the overload conditions it is not merely enough to depend upon the tube limiting device generally built into most control panels because these limits are set-up for one single exposure made on a cold anode. Instead, the technologist must consult the tube rating charts and the anode thermal characteristics charts which are based upon the stored heat units and are published for each tube. The charts will allow the technologist to determine permissible exposure values which take into consideration the heat already present in the anode from previous exposures. Only in this way can one be assured of not exceeding the anode heat storage capacity of a particular x-ray tube. One additional thing which should be noted here is that when calculating the heat units in the conventional manner, namely, PKV x MA x seconds = H. U., this method is accurate only for single phase generators. If the generator being used is a three phase generator, then the product of PKV x MA x seconds must be multiplied by 1.35 in order to obtain the actual heat units generated by a three phase exposure.

Probably the most frequent cause of tube failure is the direct result of tungsten vaporization within the x-ray tube. This vapor can originate from either the anode or the filament and in either case results in a metal coating being deposited on the inside of the glass envelope. In the case of the anode being the source of the vaporized tungsten it has been determined that when an exposure or series of exposures generates heat units in excess of the storage capacity of the anode, several harmful effects can take place, one of them being a localized melting of the anode surface. When some of the tungsten anode melts because of overheating it is immediately vaporized and subsequently deposited on the inside walls of the glass envelope of the x-ray tube. This metallic coating of the glass envelope can affect the high KV operation of the tube because it provides an additional pathway by which the high speed electrons leaving the filament can follow. Instead of passing directly from the filament to the anode, some of these electrons will "arc" across the tube to the tungsten coated glass envelope causing variations in the MA output of the tube. If the coating is great enough this "arcing" will actually puncture the glass insert thereby totally ruining the tube. In many instances this coating can be observed by looking directly through the x-ray tube port.

The second way in which vaporized tungsten is deposited on the inside of the glass envelope is by filament evaporization. X-ray tubes are generally operated in such a way that when the generator is turned on a small current flows through the filament to warm it slightly. When the rotor is started just prior to making an exposure the filament current is boosted considerably and causes the filament to become white hot. Of course, this high filament temperature is necessary during an exposure because a large number of electrons are needed to flow from the filament to the anode in order to generate x-rays. However, when the filament is "boosted" before an exposure is made, much of the tungsten being evaporated from the filament, due to its high temperature, is being deposited upon the inside of the glass envelope and gives the identical "arcing" phenomenon previously described in this article.

Another phenomenon which results from overheating the anode is a reduction in the radiation output of the tube. When heat units are generated in excess of the anode's storage capacity, internal stresses within the anode cause many tiny surface cracks to occur. When radiation is produced within a surface crack it must penetrate the surrounding tungsten peaks in order to emerge from the port. Thus, much of the radiation originating from the pitted anode is absorbed by the anode itself, resulting in a partially attenuated x-ray beam.

There are many other areas of x-ray tube failure which could also be considered, among them would be the bearings of the rotating anode and the shaft supporting the anode disk, but problems with these occur much less frequently than with the anode and the cathode and will, therefore, not be described here.

In order that the reader might effectively utilize the information herein, the remainder of this paper will be concerned with summarizing the preventive steps which, if employed, can extend tube life considerably. These recommendations are taken directly from a Machlett Company publication.

I. Anode Temperature Rise

The values shown on the Radiographic Rating Chart must not be exceeded. Where techniques permit, use less than the indicated maximum rating for extended life. It is not a good practice, particularly with three-phase generators, to use the full rating on a cold (room temperature) anode. Lower rated exposures should always precede a full maximum value exposure to reduce the "thermal shock" to the cool anode.

II. Anode Storage Capacity

For multiple exposures, the Cineradiographic, Angiographic and Anode Cooling Charts must be considered and rigidly adhered to. Again the best practice is to use less than the indicated maximum values for extended life.

III. Anode Rotation

Frequent restarts of the anode adds housing heat that detracts from the ability to accept heat from the anode. Indiscriminate use of high speeds tends to excessively wear the bearings and sudden movements of the tube should be avoided while at high speeds.

IV. Filament Life Extension

Excessive boost times must be avoided in all cases and the charts followed closely to avoid shortening the useful life. Reduction of suggested MA values for most radiographic techniques with the required increase in PKV (within limits) can greatly extend the filament life.

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Gary S. Brink, R. T.
Mallinckrodt Institute of Radiology
510 South Kingshighway
St. Louis, Missouri 63110

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Hente, Norman, R.T.
933 N. ~~Harrison~~
Kirkwood, Missouri 63122

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