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SUPPLEMENTAL
HEARING
BEFORE THE
SUBCOMMITTEE ON PUBLIC HEALTH
AND WELFARE
OF THE
COMMITTEE ON
INTERSTATE AND FOREIGN COMMERCE
HOUSE OF REPRESENTATIVES

NINETIETH CONGRESS

SECOND SESSION

ON

H.R. 10790

A BILL TO AMEND THE PUBLIC HEALTH SERVICE ACT TO
PROVIDE FOR THE PROTECTION OF THE PUBLIC HEALTH
FROM RADIATION EMISSIONS FROM ELECTRONIC PRODUCTS

(And Similar Bills)

FEBRUARY 1, 1968

Serial No. 90-27

Printed for the use of the Committee on Interstate and Foreign Commerce



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ELECTRONIC PRODUCTS RADIATION CONTROL

THURSDAY, FEBRUARY 1, 1968

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON PUBLIC HEALTH AND WELFARE,
COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE,
Washington, D.C.

The subcommittee met, pursuant to notice, at 10 a.m., in room 2123, Rayburn House Office Building, Hon. Paul G. Rogers presiding (Hon. John Jarman, chairman).

Mr. ROGERS. The subcommittee will come to order, please.

Today we are reconvening hearings on H.R. 10790 and related bills to take testimony from the Department of Health, Education, and Welfare on the subject of electronic radiation. The specific purpose of today's hearing is to receive testimony from Mr. James G. Terrill, Jr., Director of the National Center for Radiological Health. I understand that he will be able to advise the committee on the results of a television radiation survey which his office has conducted since the close of the last session of Congress.

Mr. Terrill, once again, welcome to the committee and you may now proceed in the manner that you wish.

We are very pleased to see Dr. Leon Jacobs, Deputy Assistant Secretary for Science, Office of the Secretary, HEW, and Donald J. Nelson, Jr., Assistant Director for Laboratories, National Center for Radiological Health.

The committee will be delighted to have your comments and testimony.

STATEMENT OF JAMES G. TERRILL, JR., DIRECTOR, NATIONAL CENTER FOR RADIOLOGICAL HEALTH, PUBLIC HEALTH SERVICE, DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE; ACCOMPANIED BY DR. LEON JACOBS, DEPUTY ASSISTANT SECRETARY FOR SCIENCE, OFFICE OF THE SECRETARY, HEW; AND DONALD J. NELSON, JR., ASSISTANT DIRECTOR FOR LABORATORIES, NATIONAL CENTER FOR RADIOLOGICAL HEALTH

Mr. TERRILL. Mr. Chairman, I am happy to appear before the subcommittee this morning to report to you on the survey which the Public Health Service has undertaken at the request of Secretary Gardner with respect to possible excessive X-ray emissions from color television sets in the Washington metropolitan area.

Following the survey of certain console models of color television sets conducted in Pinellas County, Fla., the Washington area survey was undertaken to determine whether sets of other manufacturers were

also emitting X-ray radiation in excess of the recommended standard issued by the National Committee on Radiation Protection and Measurements (NCRP). This recommendation is a maximum of 0.5 milliroentgen per hour at any readily accessible point, centimeters from the surface of the set under normal operating conditions.

Mr. ROGERS. This is 0.5 milliroentgen?

Mr. TERRILL. Yes.

Mr. ROGERS. At what distance from the set?

Mr. TERRILL. Roughly, 2 inches.

Mr. ROGERS. Thank you. Proceed.

Mr. TERRILL. To mount the survey rapidly, the 20,000 employees of the Public Health Service in the Washington, D.C., area were asked to volunteer their color television sets for radiation measurement. Approximately 1,200 sets of a large variety of makes and models were volunteered. The survey began in December and proceeded on an intensive schedule which has resulted, as of this morning, in all but a handful of the volunteered sets having been measured for radiation emission. These tests were made on the spot in the homes of the owners, and involved measurements on all surfaces of the sets. We are very grateful to the owners for the inconvenience which they cheerfully endured.

The National Center for Radiological Health has had the active cooperation of both the Electronic Industries Association and of individual manufacturers in conducting the survey. Technical representatives of those manufacturers whose sets were included in the survey were invited to accompany the survey teams and to provide them with technical support. The representatives assisted in certain aspects of the survey and made independent measurements of radiation from the TV receivers. The survey results we will report to Secretary Gardner will be based on radiation measurements taken by PHS personnel only.

As of today, as I indicated, the measurement of sets is virtually complete. Some 27 brands of receivers and many models of varying ages are included in the total. We have not, however, completed our analysis of the data acquired and our evaluation of its significance. We are still in the process of preparing our report for Secretary Gardner. It would thus be premature for me to characterize in anything but the most general fashion the results which we have obtained.

Nonetheless, there is one conclusion which I feel to be firmly enough established to state now. It is that the problem of excessive radiation is not limited to the sets of one manufacturer. We have obtained readings from the sets of a number of models which are in excess of the 0.5-milliroentgen-per-hour recommendation. In a few cases there were high levels of excessive radiation, but these cases were very much the exception.

I should add that we continue to have now, as we did in commencing the study, an appreciation of the limited value, from a statistical point of view, of the survey as it relates to the products of individual manufacturers.

I should add that all of the sets that we surveyed were adjusted at the time of the survey to bring them within the limits of the NCRP recommendation. This was accomplished by the substitution of tubes, the adjustment of voltage, or both.

While a precise statement of the results of our undertaking and our conclusions will not be available for some time, I feel that the project has already been successful, at least to my own satisfaction, in determining that the problem of television receiver X-radiation is one with which all television manufacturers should concern themselves.

(The PHS report on the survey was subsequently submitted, and bears on p. 25.)

Mr. TERRILL. I can assure you that we will pursue this matter energetically, both with individual manufacturers and with industry generally.

We have convened a special advisory committee on X-radiation from color television sets to advise us on survey measurement techniques and corrective measures to be taken by television manufacturers.

In cooperation with the television industry we are planning a conference on the detection and measurement of radiation from television receivers. This conference is presently planned for March 1968.

We will also consider whether further surveys are called for after the analysis of the Washington survey is completed.

Mr. Chairman, this completes my statement.

Mr. ROGERS. Are there any further remarks?

Dr. JACOBS. Mr. Chairman, I am very happy to be here to manifest the Department's interest and concern with this problem. Secretary Gardner, himself, was very concerned and to a great extent was responsible for the initiation of this Washington survey. We all are interested in the data and we want to make sure that they are analyzed as judicially and accurately as possible.

Mr. ROGERS. Thank you. Mr. Nelson, have you anything to say?

Mr. NELSON. No, Mr. Chairman.

Mr. ROGERS. Mr. Kyros?

Mr. KYROS. Mr. Terrill, what was the instrument you used to measure the radiation you are talking about?

Mr. TERRILL. We used an instrument based on the Geiger-Mueller principle which would enable us to detect radiation rapidly and to determine the measurements within any one Geiger tube in this group of Geiger tubes.

Mr. KYROS. We have heard testimony here before about instruments that have been used, principally the Victoreen Model 440 RF ionization chamber. Is this instrument similar to that?

Mr. TERRILL. Basically it is a different instrument. Our instrument is designed for survey purposes in homes and the ionization chamber would possibly be a better instrument in the laboratory and particularly if the beams were large enough so you didn't have to be concerned about differences in area.

Mr. KYROS. You have already pointed out in prior testimony, you are dealing in an area where it would be an alarming thing for people if we made any errors in measuring television sets, if we gave any unnecessary judgment that there was danger. People would be most anxious about this.

Mr. TERRILL. Yes, sir.

Mr. KYROS. Do you use a Geiger-Mueller counter in your survey?

Mr. TERRILL. It is a Geiger-Mueller-counter principle, but there are about six Geiger-Mueller tubes in the instrument.

Mr. KYROS. Do I understand it, sir, that you are satisfied this is the kind of instrument to use in this kind of survey? That this is the ideal instrument?

Mr. TERRILL. I would not say it is the ideal instrument. It is certainly a fair compromise in view of the nature of the standard and the type of survey we were trying to conduct.

Mr. KYROS. On page 2 of your statement you say that technical representatives of those manufacturers whose sets were included in the survey were advised to accompany your teams to provide them with technical support.

Mr. TERRILL. Yes, sir.

Mr. KYROS. What kind of technical support did they provide?

Mr. TERRILL. Well, first they were given an opportunity to make measurements, if they wished, with their own instrumentation.

Mr. KYROS. And they did?

Mr. TERRILL. In most cases. There might be some exceptions, but as far as I know there were none.

They were also asked to check the operating voltage and also the voltage across the picture tube, and further it was our desire to leave the home only if the radiation level had been reduced to the recommended level. They are the people who are properly responsible for correcting any deficiencies in the sets.

Mr. KYROS. Did they also have test equipment to test the levels of radiation in the particular tests in the homes you were in? That is, the technical representatives of the manufacturers?

Mr. TERRILL. Certainly some of them did, yes.

Mr. KYROS. Did you correlate your results with theirs as you went along?

Mr. TERRILL. If they used a different kind of instrument, it couldn't be correlated in the home because their readings would be dependent upon different time factors and a knowledge of the area of the beam as it relates to the area of their survey meter. These area factors could only be picked up after we placed film on the receiver and had a chance to develop the film and show them the size of the radiation beam.

Mr. KYROS. I don't completely understand this. As I understand it, the results of your tests, when measured against a standard of 0.5 mr. per hour—at a distance of five centimeters—my question to you was did you correlate the results of the tests you were making on individual sets with what they were making on the same sets?

Mr. TERRILL. You could not do this on the spot and obtain comparable results.

Mr. KYROS. What kind of instrument were they using?

Mr. TERRILL. As I understand it, most of them used a Victoreen 440 RF ionization chamber.

Mr. KYROS. In your judgment, which is the more accurate, the one you were using or the other?

Mr. TERRILL. For the purpose of this survey, our instrument.

Mr. KYROS. Was more accurate?

Mr. TERRILL. Yes.

Mr. KYROS. Did you have any opportunity subsequent to leaving the homes to make a correlation between their results and the ones that you had received?

Mr. TERRILL. We have not yet made that analysis and I am not sure we have all their data.

Mr. KYROS. That kind of surprises me because it seems to me—and I could be in error in my judgment of the testimony thus far—that we are working in areas where test results on measurements are not yet certain and precise. It seems you should be checking with the manufacturer to get their figures.

Mr. TERRILL. Yes, we have checked with them and they know as well as we do, I think, why we get these differences. But it isn't something you can put down numerically. Likewise, our film data is going to be different from our instrument data because we measure different things.

Mr. KYROS. Let me now ask you this question: Did you give the results of your test data to the manufacturers' representatives?

Mr. TERRILL. Yes.

Mr. KYROS. In each instance?

Mr. TERRILL. In each instance.

Mr. KYROS. Now, from your general knowledge, does the television industry agree generally that your choice of instrument for measurement is a sound one or correct one? Do you know whether they agree or not?

Mr. TERRILL. I suspect that they would like to have an instrument that would tend to average over a larger area. However, even our instrument was in effect a compromise. Some of you will recall that when Dr. Astin testified, he talked about measuring at a point, and to the degree we didn't measure at a point, our instrumentation tends to average also, but we simply had to choose some reasonable area over which to measure and we had to choose it partially on the basis of the way the standards were written and partially on the basis of the types of Geiger Mueller tubes and other devices that were available to us. So our instrument is a compromise. We have had it reviewed by our ad hoc committee, whose report should be available in a few weeks, and we have no reason to think that we didn't use a reasonable system. But you can argue both ways. Some people may argue that our results read far too low. Others will argue that they read too high, but this is the state of the art at the present time.

Mr. KYROS. But the answer to my question I think, Mr. Terrill, is that the television industry is not in agreement with you as to the choice of a measuring instrument.

Mr. TERRILL. I do not know. I have heard from both sides. I have heard from representatives of the industry. Some of the companies have told me—and they visited me with representatives of instrument-making companies, and they even want to adopt our instrument as a standard. Others have told me that it reads too high. We have not taken a poll. One of the things we want to do through the instrument conference we are proposing to hold in March is to find out how we could determine what the industry really thinks.

Dr. JACOBS. May I add something there, Mr. Chairman? The television industry really has not yet had a chance to make a comparison of the instrument used by the National Center for Radiological Health, with the Victoreen, or any other instrument with which they are performing their measurements. We are now at a stage where we can provide them with circuit diagrams so they can, if they wish,

develop the instruments and use them. There has not been enough time to provide instruments to them. Therefore, the comparisons have not been made, but I think Mr. Terrill might add also that when the NCRH developed this instrument, they calibrated it against the Victoreen and also calibrated it against a standard X-ray beam over a wide variety of voltages.

I think Mr. Nelson might be able to add to that.

Mr. KYROS. I don't want to cut you off, but since you are talking about the device that the National Center uses, essentially in the Washington survey, let's talk about that instrument.

First, is this a device that has ever been used by anyone other than the National Center for Radiological Health?

Mr. NELSON. The tubes in this instrument have been used for years in the radiation detection business. We think the assembly of the tubes into the circuit we use for the survey meter is somewhat unique. We have developed it and as of this time we have approximately 11 operating instruments, all of which we use for our survey operations. Personally I can say I am quite pleased with the operation of the instrument. It has performed satisfactorily in surveys of over 1,000 television sets in the homes.

Mr. KYROS. But the answer to the question is that this particular instrument is unique in that it has never been used previously by anyone else, is that correct?

Mr. NELSON. This is the opinion of our instrument designers, the particular arrangement we have used. The components are not new.

Mr. KYROS. Who developed the device?

Mr. NELSON. Primarily by Mr. Richard Stoms of my staff, and with the help of our staff in the Rockville Laboratory. It has been assembled from available parts and with the work of the laboratory we calibrated the references and response of this instrument to a calibrated ionization chamber, an instrument calibrated at the National Bureau of Standards.

Mr. KYROS. This hasn't been accepted or approved by the Bureau of Standards, however?

Mr. NELSON. No, sir. We use a system of secondary standardization where we refer our instrument to an instrument that has been calibrated at the very elaborate testing facilities operated at the Bureau of Standards.

Mr. KYROS. Has this device ever been used by any part of the electronics industry?

Mr. NELSON. This particular device, I am not sure has been used by the industry; perhaps the components have been.

Mr. KYROS. Now, in your judgment would this device be considered standard measurement testing, the use of this device?

Mr. NELSON. No, sir; at this point I would not say so. I am not sure we have a standard method of measuring radiation from television sets in home use.

Mr. KYROS. Do I understand from your testimony that you say you think this instrument will provide about the same results as the Victoreen 440 RF ionization chamber?

Mr. NELSON. In the some surveys I am quite sure we do have differences. We believe the sensitivity of the Geiger Mueller survey type instrument, the type we are using, is greater by a factor of three to

four over the sensitivity of the Victoreen ionization chamber that is used in the home to measure X-radiation beams. These differences might be significantly higher if we are dealing with very narrow beams of radiation or if we are dealing with intense beams that are spread over a very small area.

We are comparing these results. We have recorded the data in our survey, both the manufacturers' data and our own data. We are using the data obtained from the survey instrument for the tabulation of results.

Mr. KYROS. Now, this Geiger Mueller counter depends on the energy of the source.

Mr. NELSON. Almost all instrumentation has a degree of energy dependence. The response of the instrument depends upon the rate of radiation, the energy of the radiation and the shape and the uniformity of the beam. We had examined all of these factors for our instrument and have obtained correction factors for the conditions we expected in the home survey.

Mr. KYROS. Isn't it possible that this kind of energy dependence might lead to exaggerated measurements in some instances in those sets?

Mr. NELSON. In some conditions. There can be variations in instrument response which we cannot exactly determine when we are in the home measuring radiation emissions. We know what the extent of these variations might be. We know it in terms of energy dependence. It can vary by a factor of, say two to three in a downward direction. That is, our instrument will overestimate the true value. In terms of the energy dependence in the other direction—that is, underestimating the true reading—it is at least two to three in the energy dependence area and it may be of the order of six if we consider the volume that is involved in the chamber itself.

Mr. ROGERS. That is in the case of an underreading?

Mr. NELSON. Yes, sir. We would underestimate the true reading. We would underestimate the true exposure rate.

Mr. KYROS. Does your testimony also indicate that the energy dependence can result in underestimation of results?

Mr. NELSON. Yes, sir.

Mr. KYROS. However, it is a factor and it is a problem?

Mr. NELSON. It is a problem. That is right.

Mr. KYROS. Is it correct that the Geiger Mueller instrument may be influenced by RF radiation?

Mr. NELSON. We have found no such interference. Some simpler models of the GF survey meter can have RF interference.

Mr. KYROS. If there were RF radiation influence, that might exaggerate the measurements?

Mr. NELSON. This is possible, but as it turns out from our surveys, if we measure radiation and then we correct the radiation emission by replacing tubes or by correcting the voltage, the meter reading goes down so it is apparently due to radiation.

Mr. KYROS. Let me ask you this question: Is it true that this Geiger Mueller counter—in the use of the films—you used films, did you not?

Mr. TERRILL. Yes, sir, in practically every case where we had high readings.

Mr. KYROS. It omits radiation closer to the set than the 5 centimeters considered as the norm for the tests?

Mr. NELSON. We measured at the surface of the set and we actually made measurements out of 5 centimeters. We found no significant difference in these readings in our home survey.

Mr. TERRILL. The instrument automatically has a frame around it so we couldn't possibly measure closer than three-quarters of an inch from the Geiger Mueller tube anyway. Unless we scraped the instrument across the set—which I doubt if people did—we would be some distance from the surface of the set.

Mr. KYROS. You feel it was a distance of 5 centimeters or even more?

Mr. NELSON. The test data certainly provides a good estimate of the exposure rate at that point.

Mr. TERRILL. It is a small factor, if any.

Mr. KYROS. Even if it were on the surface, instead of five, you don't think it would vary?

Mr. NELSON. In no measurably significant amount, and I am speaking of some small factor of these other measurements concerned with instrument correction.

Mr. KYROS. The National Council for Radiation Protection made these tests during normal operation of the set?

Mr. TERRILL. Yes.

Mr. KYROS. Were the sets you were measuring under normal operating conditions in all cases?

Mr. TERRILL. Initially the first measurement made was the operating condition that occurred in the home at the time we entered the home and that certainly is normal in terms of the people who might be irradiated. No adjustment was made for the first measurement.

Mr. KYROS. Let's go over that again. Your definition then of normal operating conditions is what you found in the home?

Mr. TERRILL. Yes.

Mr. KYROS. Is that the definition of normal operating conditions?

Mr. TERRILL. We think it is for most health and safety purposes. It is the way people use them. As with cars, it is the way people drive the cars. It isn't the way the cars might be driven around a track or something; it is the way people use cars that determines your insurance rates and whether you need oversize brakes and everything else.

Mr. KYROS. You can have variations in line voltage, can you not?

Mr. TERRILL. You can; yes.

Of course, the initial reading we take depends upon the line voltage, the adjustment of the set, et cetera.

Mr. KYROS. You can have a repairman come in and adjust the energy level; is that right?

Mr. TERRILL. Yes, sir. Some of this could have been due to adjustment at the factory; some of it to the repairman, and I think probably some of it due to amateur adjusters in the home.

Mr. KYROS. Have you discussed with representatives of the television industry as to what they consider normal operating conditions for purposes of the test that we are talking about?

Mr. TERRILL. We have discussed this with them and we described what we considered to be normal operating conditions. I think there are some people in the industry who would have liked to have us turn the sets back to their rated conditions before we made any measurements, but I don't know that all of them would want us to do this. Per-

haps some of them who had relatively lower radiation emissions would have been very happy to leave everything just as it was.

Mr. KYROS. But apparently, sir, there would be a difference in the results, depending on what you judge to be normal operating conditions.

Mr. TERRILL. Yes. This is another factor that needs to be pinned down; yes, sir.

Mr. KYROS. Then it would seem to me that in the basic legislation we are considering, do you think it would be valuable for us to have some administrative process where industry and people like yourself could iron out some of the differences we discussed this morning and then present them to the committee? What do you think of that?

Mr. TERRILL. I think it is essential and I never considered that the legislation would—I always thought the legislation would contain such a provision and even if it didn't, I thought normal Government procedures would provide for it.

Mr. KYROS. I want to thank you for your answers to my questions. They have been very candid, enlightening, and I appreciate it very much.

Mr. NELSON. Under existing law, do you have any authority now to prohibit the distribution of the products that may be dangerous to health?

Mr. TERRILL. We do not.

Mr. NELSEN. In the investigations that had been made by your agency and also by industry, there is no dispute between your agency and the industry. It has been established there are dangerous sets in existence. This has been established?

Mr. TERRILL. Yes.

Mr. NELSEN. No one disputes it?

Mr. TERRILL. No one disputes it.

Mr. NELSEN. I notice in your testimony you plan to set up a special advisory committee to study further techniques for examination of sets; is that right?

Mr. TERRILL. This is correct. We have already established the committee. They are working on a report at the present time.

Mr. NELSEN. I also note in cooperation with the television industry you are planning a conference on the detection and measurement of radiation for television receivers, and you are planning to have this conference in March.

Mr. TERRILL. Yes, sir.

Mr. NELSEN. It would appear from your testimony that both you and industry are desirous of arriving at some unified conclusion as to techniques of detection; is that not true?

Mr. TERRILL. I think this is universally true.

I get the impression the industry is more anxious to have a solid system than they are to stick with any one instrument or another and we would be very happy if the industry came up with a better instrument that we could use for survey purposes.

Mr. NELSEN. Now in the enforcement section of this bill you state that you at the present time have no authority to deny distribution of sets that might be dangerous, but in the event this bill passes and you do get the authority, do you anticipate a large addition of personnel or do you feel you can do it pretty much with the staff people that you have?

Mr. TERRILL. I am certain we couldn't carry out the provisions with the staff people we have, because in addition to numbers it would take different types of people, because we haven't been a regulatory agency. However, it should not take a large number of people. It is mainly a matter of getting information from industry and checking on it.

Mr. NELSEN. If you do have the authority, isn't it logical to assume that the manufacturers will put their sets in order so that the dangers will not prevail in the future as has been true in the past?

Mr. TERRILL. I think this is a logical assumption.

Mr. NELSEN. Now, let us assume that some repairman comes in and does not know his business, some very dangerous things could happen. If a serviceman fools around with the set and doesn't know what he is doing, couldn't this happen?

Mr. TERRILL. Yes, sir.

Mr. NELSEN. How would you guard against that?

Mr. TERRILL. I think there are at least several ways to guard against that. One is to intensify the training effort that is already started in the industry, and also to consider ways of controlling voltage and putting in secondary shielding and improving components so that the likelihood of having some combination of defective shielding, defective components, and voltage will disappear.

Mr. NELSEN. I want to say, as I view the testimony, actually industry and your agency are all in agreement that some standards need to be established. Will there be an attempt to work it out between the manufacturers and your agency to get a satisfactory means of detection?

Mr. TERRILL. That is correct.

Mr. NELSEN. Thank you. I have no further questions.

Mr. CARTER. I notice in your statement you state the problem of excessive radiation is not limited to the sets of one manufacturer. This was brought out during hearings which were held last year.

GE was referred to as having defective sets, and I think we have done a disservice to that company. As we see now, the bad effects are not limited to one company. I regret this very much. Is this the case?

Mr. TERRILL. I think the publicity could have given this impression, but I think that we mentioned in our testimony that it was a component problem, that these components were manufactured by other companies and, on theoretical grounds at least, other companies could have been involved.

Mr. CARTER. They could have been, but not that they were?

Mr. TERRILL. This Washington survey was the first survey where we made an effort to determine if other companies were involved; yes, sir.

Mr. CARTER. I remember only one company was referred to and other companies were not named as having these defects in color TV's. Don't you think that is a little bit regrettable, that we should search out one company, even before we thought this thing out?

Mr. TERRILL. Of course, we didn't choose the timing, sir.

Mr. CARTER. It has caused irreparable harm to single that particular company out.

Mr. TERRILL. Yes; it might, but this was never our intention.

Mr. CARTER. Do you think the legislation which may be passed concerning color television, that this should be monitored by Public Health

Service, or the Bureau of Standards? Which group at the present time is better fitted to look after this?

Mr. TERRILL. I don't think there is any question about it; the Public Health Service. I think the Bureau of Standards is an excellent organization to establish basic standards, but I can't recall any instance when it did any operating public health work.

Mr. CARTER. It is not capable or doesn't have sufficient manpower to do this at the present time; is that right?

Mr. TERRILL. I don't know what their manpower situation is. I only say they have not been in this kind of a business.

Mr. CARTER. Are you sure they haven't been in this kind of business, that they are not familiar with this type of work?

Mr. TERRILL. They have been asked if they have this kind of an organization; if they have, it is unknown to us.

Mr. CARTER. They testified during the hearings last year that they could do these things. I think you will find that in the hearings last year.

Mr. TERRILL. As I recall, Dr. Astin, speaking for the Department of Commerce, spoke in support of the idea that this bill should be administered by the Department of Health, Education, and Welfare.

Mr. CARTER. We can look that up to be sure about it. I am sure they said they had the capabilities.

Dr. JACOBS. Mr. Chairman, I think we can respond to Mr. Carter with the record of the testimony. On page 119 of the record Mr. Astin responded to a question of Mr. Carter:

Mr. CARTER. Would your agency like to develop these standards?

Mr. ASTIN. No, sir, we are primarily interested within the National Bureau of Standards in providing the technological base which facilitates the setting of standards. The NBS has no regulatory responsibilities, it seeks none.

Mr. TERRILL. That was my understanding, also.

Mr. CARTER. I suppose I misunderstood that. I will check into it again. I will be glad to look that over.

That is all, Mr. Chairman. Thank you.

Mr. ROGERS. Thank you, Mr. Carter.

As I understand it from your survey, which you have not finally completed the analysis of, what is the period of time?

Mr. TERRILL. Our plan is to have the survey coordinated with the report of our advisory committee in the next few weeks.

Mr. ROGERS. Could you be more definite—four, five, three, two?

Mr. TERRILL. Well, I'd like to be more definite. Let's say four. That is a good compromise.

Mr. ROGERS. I think this committee would like to see the specifics, after you have analyzed this.

As I understand it, the industry has cooperated. I commend the industry for trying to be helpful in meeting the problem as well as they can.

Also, I commend the Service for the very rapid work you have done. You have been pushed in this very hard, I know. This survey was made in a very short period of time and all of the citizens who contributed by letting their sets be measured I am sure are to be commended.

As I understand it, you are not ready to use names of companies?

Mr. TERRILL. That is correct.

Mr. ROGER. And say what was found on the sets of individual companies, yes?

Mr. TERRILL. That is correct.

Mr. ROGERS. You will be able to do this at the end of 4 weeks?

Mr. TERRILL. I would not want to say this because the survey was not set up to do this. In any group, such as our employees, we are not at all certain in the first place that it is typical of the distribution of the sets and in the second place there are some manufacturers whose sets were present in such small numbers that we could unduly exaggerate either their relative safety or the relative emissions from the sets.

Mr. ROGERS. Then do you plan to conduct sufficient surveys in the near future, then, that would be able to give you satisfactory information?

Mr. TERRILL. If this seems to be the best way to approach the problem. It may be that through the analysis data we can lower the radiation emissions more rapidly by concentrating on components and checking on components than we can by checking brand names of television sets. Should this be the case, I think we should try to emphasize that point.

Mr. ROGERS. I have no strong feeling about that except that we want to get to the problem. Certainly we do not want to do damage to any business, but we do not want to do damage to the public, either.

Mr. TERRILL. That is correct.

Mr. ROGERS. This is the underlying thesis I hope you will proceed on. This should be brought out. It was brought out by the General Electric Co.

Mr. TERRILL. If there is a dominant factor it should be brought out but sometimes the tubes that are generating most of the radiation may be manufactured under a different brand name than the set and if this is the case, we have to have some procedure that would be fair both to the set manufacturer and to the component manufacturer.

Mr. ROGERS. Have you and the industry determined where radiation comes from in the set? Do you agree?

Mr. TERRILL. I think we largely agree.

Mr. ROGERS. Where are those places?

Mr. TERRILL. The picture tube, the shunt regulator tube, and the rectifier.

Mr. ROGERS. Have you identified the areas that create the problem, other than the areas they come from? For instance, voltage?

Mr. TERRILL. Voltage, yes.

Mr. ROGERS. What happens on the voltage problem?

Mr. TERRILL. The sets, of course, were designed both from the standpoint of operations, and also from X-ray protection operated at certain voltage. However, due to line voltage which they cannot control, and due to adjustments which service people or the factory might make, these voltages are exceeded and when they are exceeded the X-ray product tends to go up very rapidly.

Mr. ROGERS. How fast does it go up? Suppose you start at 25,000 kilovolts and it goes up a thousand?

Mr. TERRILL. The highest individual reading that I can recall is of the order of 33 kilovolts, but there might have been higher voltages recorded.

Mr. ROGERS. What is the real relation of increase in radiation to the increase in voltage?

Mr. TERRILL. It varies as a power function of voltage. A power function of about, probably in this range of eight, which means a very rapid increase of X-rays with voltage.

Mr. ROGERS. So each increase in voltage brings about how much radiation increase?

Mr. TERRILL. A very rapid increase. You would have to put it on a slide rule to come up with numbers quickly.

Mr. ROGERS. It is extremely rapid, as I understand it.

Mr. TERRILL. It is quite rapid; yes, sir.

Mr. ROGERS. What other factors are of great importance that you think of, other than identifying the areas and the problem of voltage?

Mr. TERRILL. I think another thing is secondary shielding, both in terms of what is inherent in any device and also the special shielding that may be placed around the tubes or the special shielding that may be built into picture tubing.

Mr. ROGERS. I notice in your testimony that this problem after your survey you can draw the conclusion that it is not restricted to one manufacturer.

Mr. TERRILL. Yes.

Mr. ROGERS. So it is an industrywide problem, do you say, or what?

Mr. TERRILL. On the basis of our limited survey, we would say, yes.

Mr. ROGERS. I understand the manufacturers do not agree necessarily with the testing procedure used. There is a question about this that Mr. Kyros went into.

Mr. TERRILL. I do not know what the manufacturers in toto think. I know that they do not like getting high readings. I think they would dislike even more if we based our conclusions on the film readings that we have gotten. But you have to more or less adopt some kind of a reasonable standard for presentation of information to a group such as your own. It works both ways.

Mr. ROGERS. You have no reason, in designing your testing facility, to show either high readings or low readings?

Mr. TERRILL. No. We asked them if they had a better system. We were anxious to have a better system because we had to generate these instruments ourselves in our own laboratory and it was tough.

Mr. ROGERS. Is it true that there was also testing done in Pinellas County?

Mr. TERRILL. Yes, sir.

Mr. ROGERS. Are you familiar with this testing?

Mr. TERRILL. Yes, sir.

Mr. ROGERS. Was this done on sets other than General Electric?

Mr. TERRILL. No; that was done specifically on the GE sets to test the effectiveness of their correction program.

Mr. ROGERS. I received a letter on a survey made from December 1 to January 17 of this year. I do not know whether you have received that yet from the Pinellas County Health Department. Do you recall that?

Mr. TERRILL. I did not receive it.

Mr. NELSON. I believe the Pinellas County Health Department has conducted additional surveys on their own after we completed our joint pilot study with them, and we understand they are making a number of measurements on other types of television receivers.

Mr. ROGERS. This survey comes to the same conclusion that you have drawn from your survey, in that it is not restricted to one manufacturer.

Mr. TERRILL. Yes, sir.

Mr. ROGERS. They found 18 out of about 110 sets were emitting excess radiation. That would be about a 16.4 percent, according to this letter.

Now, the TV repairmen can take these sets—is this true industry-wide—and increase voltage. Is there a way to increase voltage on the sets?

Mr. TERRILL. There is a way to adjust the voltage; yes, sir.

Mr. ROGERS. Is this generally true on all sets?

Mr. TERRILL. I have heard of no set where the voltage adjustment cannot be made. There may be. But we have heard of none.

Mr. ROGERS. So that a set may go out from the manufacturer, tested at a proper level.

Mr. TERRILL. Yes, sir.

Mr. ROGERS. But once in the home, after being taken to a repair shop to be completely changed so that it could give an excess of radiation if the voltage is upped significantly.

Mr. TERRILL. This is correct.

Mr. ROGERS. I presume you say this is one area that you try to get with industry to see what can be done.

Mr. TERRILL. Yes, sir.

Mr. ROGERS. I was interested in Mr. Kyros' question about the normal operating procedure of sets. I would agree with you that the normal operation that we are concerned with is in the home and how it is being used. I think the survey that you made would indicate that this is a normal operating procedure.

Mr. TERRILL. Yes.

Mr. ROGERS. It is pointed up that, perhaps, repair shops may be creating this problem, too.

Mr. TERRILL. They could be.

Mr. ROGERS. Is Public Health doing anything about putting out a booklet or information to repair shops requiring that these booklets be placed in the shops and be read by people?

Mr. TERRILL. We have asked all of the manufacturers to put out such a booklet.

There may be some exceptions, but I believe all of the manufacturers, certainly the major ones, have put out such a booklet. Just how effective it will be is yet to be determined.

Mr. ROGERS. I wonder if it would be helpful to the Public Health Service. Have you given any thought to this? It might have more impact.

Mr. TERRILL. We have given thought to this and have started to pull together the viewpoints of the different manufacturers on this. We would hope to go over our consolidation with them and also with people like labor unions who are also involved, and consumer union people, to see if we can pull together something that will do the best job.

Mr. ROGERS. I have pictures here that I will submit for the record from Pinellas County showing repair people working directly over the sets while they are on; sets out of the protection shielding. This does not go to the general public, but this does apply to repairmen.

Mr. TERRILL. Yes, sir.

Mr. ROGERS. Presumably that would be a very unwise procedure to use; would it not?

Mr. TERRILL. It would be unwise unless they had good radiation instrumentation.

Mr. ROGERS. Let me ask this: As I understand it, the Surgeon General has already issued instructions, or suggestions, as to use of color television as far as distance is concerned.

Mr. TERRILL. Yes, sir.

Mr. ROGERS. How has this been disseminated; that is, this information, to the public?

Mr. TERRILL. It was disseminated by a press release. I could not give you the total coverage and effectiveness of this press release offhand. Perhaps we could make some estimate as to the numbers of people that it reached. I know from talking to friends of mine who are not connected with the business that a number of them have seen this in articles of various types.

Mr. ROGERS. What was his suggestion to the public?

Mr. TERRILL. His suggestion was that people should sit from 6 to 10 feet from the television receiver, and also try to avoid being in direct contact with it if they were not viewers. This is consistent also with the makeup and the background of the NCRP standard, where an allowance was made for distance in recommending the standard. The 0.5 milliroentgen per hour is probably a suitable standard only if people respond and limit themselves to viewing from a reasonable distance.

Mr. ROGERS. I understand that in your survey you said you found a few sets that had extremely high radiation.

Mr. TERRILL. Yes, sir.

Mr. ROGERS. Were these as a result of increased voltage, do you feel, or what?

Mr. TERRILL. I could not state this offhand. We will certainly have this in our report.

Mr. ROGERS. I will submit for the record the statement from Pinellas County Health Department with their survey. This material also includes a number of pictures of television service technicians making electronic adjustments on color television receivers without observing any safety practices to protect themselves from X-radiation emissions. These pictures and their descriptions will accompany the record and be kept in the committee's files.

(The documents referred to follow :)

PINELLAS COUNTY HEALTH DEPARTMENT,
St. Petersburg, Fla., January 19, 1968.

Mr. DON SMITH,
National Center for Radiological Health,
Rockville, Md.

DEAR DON: In accordance with our recent telephone conversation, we are enclosing herewith a report on results of color television surveys made since the end of our joint survey of the General Electric receivers.

The numbers given in the first column are not control numbers. They have no purpose other than to show the number of sets involved and as a reference number for any further questions or information you may have in connection with the report.

Eighteen (18) of the 110 sets (about 16.4%) surveyed during this period were found to be emitting in excess. This is somewhat lower than the averages obtained by the power company. Even so, the radiation problem was eliminated by reset-higher line voltages within the range specified by Florida Power Corporation. We had access to voltage measuring equipment only when repairmen were present to correct known problems. A line voltage of 130 was encountered in one case, which was the Holiday Inn, Clearwater. The manager did not want the voltage reduced by other surveys; however, we would point out that more would have emitted at ting the anode voltage.

Please let us know if you wish to receive further information on any of these surveys.

Very truly yours,

GEORGE R. MCCALL,
Public Health Physicist.

COLOR TELEVISION SURVEY RESULTS, DEC. 1, 1967-JAN. 17, 1968, PINELLAS COUNTY HEALTH DEPARTMENT, ST. PETERSBURG, FLA.

No.	Manufacturer	Model No.	Dose rate (mr./hr.)	Location	Source	Line volt- age (v.)	Anode volt- age (kv.)
1	Admiral	L 211 M	Bkg.				
2	do.	do.	Bkg.				
3	do.	T 1000	Bkg.				
4	do.	L 5421	0.05	Rear	S ¹ & R ²		
5	do.	LN 5711	0.1	Left	S & R		
6	do.	LN 5761	0.36	Rear	S & R		
7	do.	LS 1311	> 100.0	Bottom	S	119	23.5
8	Ambassador	2950	0.1	do.	S	119	23.5
9	Bradford	S-WGE-59567A	Bkg.				
10	Curtis-Mathis	50M782	Bkg.				
11	do.	CV221B	0.12	Front	Picture tube		
12	General Electric	M960BWD	Bkg.	do.	Picture tube		
13	do.	M933AWD	Bkg.				
14	do.	M958ACL	Bkg.				
15	do.	M921AWD	Bkg.				
16	do.	M258CWD	Bkg.				
17	do.	M961BCD	180.0	Left	R	122	29.5
18	Replaced 6EA4 with 6EH4A		Bkg.				
19	Replaced 6EA4 with M971B		93.0	Left	R		
20	Motorola	23LK412B	Bkg.	Top			
21	do.	CV612CM	Bkg.				
22	do.	WL85VS	Bkg.				
23	do.	C5790DW	0.032	Left	S & R		
24	do.	(C)	0.024	Rear	S & R		
25	Olympia	TS-914B-061 (chassis)	Bkg.				
26	Philco	CK3370	0.024	Rear	S & R		
27	do.	P6404PC	Bkg.				
28	do.	6536	Bkg.				
29	Philco	17MTDA	0.03	Left	S & R		
30	do.	A53281S	0.06	Front	Picture tube		
31	do.	A53281S	Bkg.				
32	do.	A53281S	Bkg.				
33	do.	A53281S	Bkg.				
34	do.	A53281S	Bkg.				

See footnotes at end of table.

COLOR TELEVISION SURVEY RESULTS, DEC. 1, 1967-JAN. 17, 1968, PINELLAS COUNTY HEALTH DEPARTMENT, ST. PETERSBURG, FLA.—Continued

No.	Manufacturer	Model No.	Dose rate (mr./hr.)	Location	Source	Line voltage (v.)	Anode voltage (kv.)
35	do	15M91	0.11	Front	Picture tube	117	30.0
			0.10	Rear	S	117	30.0
			0.60	Top	S	117	30.0
			0.74	Left	S	117	30.0
			0.03	Bottom	S	117	30.0
			0.10	Left	S	117	24.0
			0.03	Left	S	117	24.0
			10.00	Rear	S. & R.	118	28.0
			0.40	Front	Picture tube	118	28.0
			0.20	Left	S. & R.	118	28.0
			0.25	Rear	S. & R.	118	24.5
37	R.C.A.	GH676W	Bkg	Top	S. & R.	125	30.0
38	R.C.A.	GH608W	0.31	Front	Picture tube	125	30.0
			0.20	Front	Picture tube	125	24.5
39	R.C.A.	GH652M	Bkg				
40	R.C.A.	GH720H	Bkg				
41	R.C.A.		Bkg				
42	R.C.A.	213G155MV	0.08	Rear	S. & R.		
43	Sears	61502	Bkg				
44	do	312924	Bkg				
45	do	7181	Bkg				
46	do	8135	Bkg				
47	Satchel-Carlson	3C166	0.0	Left	S. & R.	110	28.0
			0.4	Front	Picture tube	110	28.0
			0.7	Rear	S. & R.	110	28.0
			0.7	Left	S. & R.	110	28.0
			Bkg.			110	22.5
68K4B replaced w/68K4B							
Anode volt. could not be brought down—unit replaced.							
48	Sylvania	(1)	Bkg				
49	Telefunken	632	Bkg				
50	Heathkit	295	0.08	Front	Picture tube		
51	Wards Airline	6251	Bkg				
52	do	HJ88546A	Bkg				
53	do	GH18146C	0.78	Bottom	Picture tube	115	28.0
			0.70	Left	do	115	28.0
			0.28	Top	do	115	28.0
			0.28	Right	do	115	28.0
			0.08	Back	do	115	28.0
			0.48	Front	do	115	28.0
			Bkg			115	(3)
68K4B replaced w/68K4B							

54	Wards Airline	GHJ8256	3.0	Left	S & R	130	28.5
54	do	GHJ8256	0.20	Right	S & R	130	28.5
			0.40	Rear	S & R	130	28.5
			0.20	Front	Picture tube	130	28.5
55	6BK47 replaced w/6BK47		Bkg ≤ 0.5				(3)
90	Westinghouse (36 each)	CP19AH70	0.53	Left	R	(3)	27.0
91	Westinghouse	CP19AH70	0.70	do	R	125	27.0
92	do	CP19AH70	0.80	Rear	R	125	25.0
			0.05	do	R	125	26.0
	Anode voltage adjustment	CP19AH70	0.54	do	R	125	26.0
93	Westinghouse	CP19AH70	0.20	Left	R	125	25.0
			0.30	Rear	R	125	25.0
94	Anode voltage adjustment	CP19AH70	0.56	Left	R	125	26.0
			0.50	Rear	R	125	26.0
95	do	CP19AH70	0.60	Left	R	125	27.0
			0.20	Rear	R	125	27.0
96	Anode voltage adjusted	CP19AH70	0.06	Left	R	125	25.0
			1.20	do	R	125	(3)
			0.13	Top	R	125	(3)
			0.30	Rear	R	125	(3)
			0.10	Left	R	125	24.0
97	Anode voltage adjusted (by observing readings on Nuc-Chicago GMI)	CP19AH70	0.52	do	R	124	28.0
			0.30	Rear	R	124	28.0
			0.04	Left	R	124	25.0
98	Anode voltage adjusted	H-CK6530	Bkg	Bottom	S	120	27.0
99	Zenith	62260D	2.0	do	S	118	25.0
100	Zenith	(3)	0.40			118	24.5
101	do	S2959-1	Bkg				
102	do	5030	Bkg				
103	do	(3)	Bkg				
104	do	T2963	Bkg				
105	do	T2910	Bkg				
106	do	X4541	0.042	Front	Picture tube		
107	do	(3)	Bkg				
108	do	S2951	Bkg				
109	do	8322-1	Bkg				
110	do	83086	1.76	Left	S & R	119	28.0
	Ozone odor		0.55	Rear	S & R	119	28.0
			0.40	Front	Picture tube	119	28.0
	Anode voltage adjusted		1.10	Left	S & R	119	26.0
	do		1.00	do	S & R	119	25.5
	6BK47 replaced w/6BK47		0.8	do	S & R	119	25.5
	Rectifier replaced w/3A12		1.5	do	S & R	119	25.5

¹ S—shunt regulator. ² R—rectifier. ³ Unknown.

Mr. ROGERS. Is there anything you might like to comment on that Pinellas study?

Mr. TERRILL. I think we should say for the record that the correction program of General Electric seemed to be effective on the basis of our study. I think we ought to also thank the General Electric Co. for providing us with technical assistance down there. I hope that it is representative of the effectiveness of the General Electric program across the country.

Dr. JACOBS. I would like to add something to that, Mr. Chairman. I think the attitude of General Electric about this problem has been most gratifying. They have not only been cooperating in that respect, but in discussions with them I have found out how they have developed new methods of examining their product as it is coming off the line, and from the shelves, and I think they are to be commended for making a very definite effort to improve the conditions of their sets.

Mr. ROGERS. I would agree. I think all of the industry has been most helpful in trying to work out this problem in a reasonable way. Their testimony was helpful to the committee in stating they had no basic objections to the passage of this legislation for the protection of the public. Are there any other questions?

Mr. KYROS. I have a few questions, Mr. Chairman.

I want to return for a moment to the test criteria of achieving the tests under normal operating conditions.

Mr. TERRILL. Yes, sir.

Mr. KYROS. A repairman can come in and make an adjustment on the set and maybe there is a larger voltage or a short develops. The test for determining emission should be taken under normal operating conditions; that is, adjusting the set so it is within the normal operating range; is that not correct; otherwise, how can you compare the sets?

Mr. TERRILL. We were basically interested in checking on emissions. Each set manufacturer's operating conditions—that is, normal operating conditions—vary, too. I think this is one of the things that we would have to work out through this conference procedure. It would be perfectly logical to design a set to operate at 30 kilovolts instead of 25, provided every part of the design takes this into consideration.

Mr. KYROS. The point I want to make, and I think you have already touched on it, is this: There is no question that once the set is put in a household it is already set up under normal operating conditions.

What you do in the household is to determine what the sets are actually doing and whether their emissions are beyond the standards of safety set by the National Council. That is one thing.

Mr. TERRILL. That is right.

Mr. KYROS. The other thing is to say that industry is turning out sets which are supposed to operate within normal operating conditions, barring some third party adjusting the set, and that the set, when it came out of the plant and was initially put in the house, was within the safe standards is another thing altogether.

Mr. TERRILL. We agree, and this is one of the problems we have to try to work out in our report.

We do not want to claim that the set was manufactured as we found it. We simply do not know if this is the case.

Mr. KYROS. The second point I want to make is this——

Mr. ROGERS. Would the gentleman permit me just a question here?

Mr. KYROS. Surely.

Mr. ROGERS. I do not agree with the conclusions that have been drawn at all on this. For instance, many sets have been found without adjustments in the home that were emitting X-rays.

Mr. TERRILL. That is correct.

Mr. ROGERS. There was no adjustment at all involved with the tubes; is that not correct?

Mr. TERRILL. That is correct.

Mr. ROGERS. I would not want the gentleman to give the impression that every set only develops radiation after it gets in the home and someone changes the voltage.

The point I think should be made clear is that it can happen both ways.

Mr. TERRILL. That is correct.

Mr. ROGERS. But this is the problem we want to get at. If we can do something and bring it to the industry's attention, maybe they can fix the set where the voltage cannot be increased by a repairman, and then you have solved the problem from the repairman's point of view.

Mr. TERRILL. Precisely.

Mr. ROGERS. We are trying to get at problems that are operating normally in the home.

What we are trying to do is to protect the public from radiation and not any particular manufacturer from some adverse publicity.

Mr. TERRILL. That is to be our point of emphasis, that we have to take these other factors into consideration.

Mr. ROGERS. I thank the gentleman for yielding.

Mr. KYROS. I think your remarks, Mr. Chairman, are very well stated. The only point I wish to make is this, that we are dealing here with a large segment of American industry on which we rely greatly. I think you will agree, Mr. Terrill, that we isolate what possible errors might have occurred in the past, and it is vital, I think, to show that when they set up these sets they did or did not meet the original standards that were set up. That is why I said what originally was the meaning of the phrase "normal operating conditions." It seems to me except for what my colleague has just mentioned, that by and large they have met, within normal operating conditions, the standards. You have found sets operating within normal operating conditions that still do not meet the standard.

Mr. TERRILL. Yes.

Mr. KYROS. I think what is important is that in your report you isolate what they did within normal operating conditions in a set in a particular house where you found the set that was operating within that standard. We will know historically what the nature of the problem is. Do you understand my point?

Mr. TERRILL. I understand what you mean, but I think this normal operating condition, as you have defined it, is an understanding that the industry arrived at among themselves rather than going back to the NCRP when the standard was first written to identify what NCRP meant.

From my conversations with NCRP they are still wrestling with this problem, because we have asked them. We merely took as our interpretation of normal for this form interpretations of what is considered normal operating conditions in related health fields. The interpretation is not one that necessarily suited our purposes.

Mr. KYROS. There was one more point you brought up that I would like to ask you a couple of questions about. Do you want to leave on the record here today that the industry was in agreement with you as to the test device you used in this particular test?

Mr. TERRILL. I do not want to leave it on record. I merely say that we described the instrument first to the General Electric Co. and second to the industry through a representative group assembled by the EIA. We described our procedures to them in detail. We would have been very happy if over a period of 9 years or so that the NCRP recommendations existed, if industry had presented us with a fine instrument that had gone through the standardization procedures, where there had been a history of how they tested it, and how they proposed to use it in the field, and so forth. This would have been ideal. After all, they have much more electronic competence than we do. But this was not the case. We were requested to go out and make a check, and we had to do the best we could. But we certainly presented our plans to them. We sat around the table just like we are sitting around here, and said, "Fellows, if you have something better, let us have it."

Mr. KYROS. Then the answer to my question still is there was not agreement between you and the industry as to what the test device was to be.

Mr. TERRILL. There was also not disagreement.

Mr. KYROS. Thank you very much.

Mr. ROGERS. Congressman Carter.

Mr. CARTER. In your recent examination of 1,200 sets by the people in the Public Health Service, what direction from these sets did you find most of the X-rays emanating?

Mr. TERRILL. Sir, I could not give you that offhand. I could only tell you we found some radiation in every direction. I can also say, as I recall, most of it came out of the left side of the television set as we would face it. Isn't that correct?

Mr. NELSON. Yes, sir.

Mr. CARTER. I think the hearings last year bore out that most of the X-rays emitted went downward; is that not true?

Mr. TERRILL. This was true with regard to the emphasis we had at that time in the hearings on a certain model of the GE set.

Mr. CARTER. This is true according to the GE sets.

Mr. TERRILL. I would not want to say it is true of all GE sets. It was this particular model that was emphasized in the last hearings.

Mr. CARTER. Now you find that the X-rays are being emitted in all directions.

Mr. TERRILL. Yes.

Mr. CARTER. In the front?

Mr. TERRILL. Yes.

Mr. CARTER. And possibly as much in one direction as in another.

Mr. TERRILL. I do not think so. I think in general the emissions that come through the cabinet are on the left or tend to be out of the left side of the set.

This may be due to the fact that they are all probably based on the same original patents.

Mr. CARTER. Are these rays emitted from the left rear backward or toward the front?

Mr. TERRILL. Both.

Mr. CARTER. Both ways?

Mr. TERRILL. Yes, sir. The picture tube is partially designed to serve as a shield; whereas in some sets they do not necessarily have shielding material on the sides or in the rear.

But you always have some shielding material in the front.

Mr. CARTER. Was there an understanding that perhaps the picture tube caused the emission of most of the X-rays, and is that still true?

Mr. TERRILL. I do not think this is true.

Mr. CARTER. In fact, the tubes went through considerable alteration, did they not? In my State of Kentucky, at Owensboro, I understand they did change the tubes. Is that not true?

Mr. TERRILL. It is my understanding that the industry consistently has emphasized the question of possible radiation from the picture tube. From the very beginning they have possibly done more research and development on this than on anything else.

I am quite certain they are continuing to do this. It would not surprise me if they were putting out better tubes from a radiation standpoint now than they were a year ago.

Mr. CARTER. You think they are putting out better ones. You do not know this to be true?

Mr. TERRILL. This is our first survey and we could not say this on the basis of our own data.

Mr. CARTER. We understood that several were quite dangerous and GE had recalled several, and they have been able to get all back except in the neighborhood of 1,000.

Mr. TERRILL. I think this was with regard to the shunt regulator tube.

Mr. CARTER. It was not the picture tube?

Mr. TERRILL. No, sir. Improvements have been made in the shunt regulator tube.

Mr. CARTER. Thank you, Mr. Chairman.

Mr. ROGERS. And also the shielding problems has been changed, has it not?

Mr. TERRILL. Yes.

Mr. ROGERS. To help that particular problem.

Mr. TERRILL. Yes, sir.

Mr. ROGERS. Can you tell me if the methods used by the Pinellas County Public Health Service were about the same as you have been using, or not?

Mr. TERRILL. They borrowed the instruments from us, I believe. Of course, we jointly made the General Electric survey.

So unless they came up with some better techniques, which is quite possible, I think they are consistent.

Mr. ROGERS. I see that our colleague, Congressman Brown of Ohio, has come in. We are delighted to see you this morning.

Are there any other questions?

Mr. KYROS. No, thank you, Mr. Chairman.

Mr. ROGERS. The committee would appreciate your reporting back to the committee on the final results of the survey.

Mr. TERRILL. Yes, sir, we will do this.

Mr. ROGERS. We would appreciate that being given to the committee as soon as it is available.

Mr. TERRILL. Yes, sir.

(The survey report referred to follows:)

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE,
OFFICE OF THE SECRETARY,
Washington, D.C., March 15, 1968.

HON. HARLEY O. STAGGERS,
Chairman, Interstate and Foreign Commerce Committee,
House of Representatives,
Washington, D.C.

DEAR MR. CHAIRMAN: As you know, the Secretary recently asked the Public Health Service to conduct a survey of color television sets produced by a variety of manufacturers to ascertain if the problem of emission of excessive radiation was industrywide. I have received today from the Surgeon General the report to the Secretary prepared by the National Center for Radiological Health on its recent survey of color television receivers in the Washington, D.C. area.

Although we have not yet completed our final review of this report, I am forwarding two copies today in view of its timeliness in connection with pending legislation on radiation from electronic products.

You will be interested to know that the subject of instrumentation and methods for measurement of X-radiation from television sets will be discussed at a conference organized by the National Center for Radiological Health to be held on the 28th and 29th of this month.

We continue to appreciate your active support for increased protection of the public from radiation hazards.

Sincerely yours,

PHILIP R. LEE, M.D.,
Assistant Secretary for Health and Scientific Affairs.

**A SURVEY OF X-RADIATION
FROM COLOR TELEVISION SETS IN THE
WASHINGTON, D.C. METROPOLITAN AREA**

by

Technical Services Branch

March 12, 1968

**U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
National Center for Radiological Health
Rockville, Maryland 20852**

(25)

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FOREWORD

This report presents findings of a survey of X-radiation emissions from color television receivers conducted by the National Center for Radiological Health with the active cooperation of the Electronic Industries Association and the individual manufacturers. The survey was undertaken after a pilot survey in Pinellas County, Florida, designed to measure the effectiveness of a shunt regulator correction program, indicated radiation emissions were occurring from components common to the industry. The purpose of this survey was to obtain information on the X-ray emission of television receivers of all manufacturers included in a sample of color television receivers in use in the homes of Public Health Service employees in the Washington, D. C. area. The sample was obtained by means of a questionnaire addressed to Public Health Service employees in the Washington, D.C. Metropolitan Area, who were asked to volunteer their sets for radiation measurements.

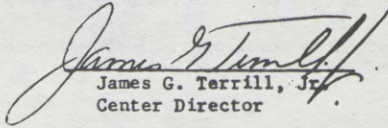
With the assistance of the Electronic Industries Association, technical representatives from each of the manufacturers whose sets happened to be in the sample were asked to provide technical support for the survey team.

The individual manufacturer representatives assisted in obtaining set identification and made measurements of the household line voltage and the operating high voltage in the television receivers examined. The industry representatives also replaced certain high voltage tubes and made other adjustments to reduce radiation emissions in any set exceeding the level recommended by the National Council on Radiation Protection and Measurements.

The results given in our report are applicable to the sample of television receivers in the Washington Metropolitan Area and may not be representative of national X-radiation emission from television receivers.

In addition to data on radiation levels, the survey provided information as to the causes of radiation emissions and corrective action which can be taken by industry to prevent unnecessary radiation exposure to the public.

We hope that the report will be useful to the industry and other official agencies who are planning future activities and programs relating to the control of radiation emissions from electronic products.



James G. Terrill, Jr.
Center Director

A Survey of X-radiation from Color Television Sets
in the Washington, D. C. Metropolitan Area

INTRODUCTION

The Public Health Service conducted a survey of X-ray emissions from a sample of color television sets in the Washington, D.C. Metropolitan Area with active industry cooperation. Previous tests conducted by the Public Health Service had shown that X-radiation from color television receivers is related to (1) certain operating parameters, primarily high voltage, (2) excessive emission from components, and (3) inadequate shielding of components emitting X-radiation (Ref. 1 & 5). There were a number of considerations which led to the interest in determining whether X-radiation emission was an industry-wide problem, including the knowledge that all color TV sets contained high voltage rectifiers and picture tubes which could produce X-rays, and that many of the sets had shunt regulator tubes which could also produce X-rays. In many instances, the components originating in both domestic and foreign plants are used on an industry-wide basis. Likewise, only a few manufacturers provide the basic materials from which many components are produced. It was also expected that excessive emissions might be related to actions by the servicing industry and to variations in local power supplies which would tend to affect the sets of all manufacturers.

In addition to these technical reasons, surveys made up to this time had largely concentrated attention on one manufacturer. In some other instances in which a very small number of sets had been tested, published comments had indicated some receivers showed excessive X-radiation emissions whereas it

was probable that these evaluations had not been based upon sufficient data to justify a firm conclusion. In order to obtain a sample which might provide more information on receivers of many manufacturers, and within the logistic capabilities of the National Center for Radiological Health, employees of the Public Health Service in the Washington, D.C. area were asked to volunteer their color television sets for radiation measurements. The owners of the sets were requested to complete a questionnaire with specific information on make and picture tube size. The request led to the availability for survey purposes of 1,124 color television receivers of a variety of brand names and models from 21 domestic and five foreign manufacturers.

SURVEY METHODS AND OPERATION

Protocol

Visits to homes to obtain X-radiation emission measurements and other essential data were started on December 16, 1967. As many as nine teams, normally consisting of two representatives from the Public Health Service and two representatives from a manufacturer, were in the field during the survey. Appointments were arranged a day or two in advance to permit approximately three home visits every two hours. A maximum of 14 visits per day per team was possible with the average being seven per day.

Representatives from 21 domestic manufacturers, five foreign manufacturers, and two retail distributors assisted in the surveys. Manufacturers representatives assisted in obtaining the model and serial numbers of the receiver, and the brand and code number of the shunt regulator, rectifier, and picture tubes. Representatives also made measurements of household line voltage and the operating high voltage. Industry representatives were scheduled to participate only in those surveys involving sets which they manufactured or distributed.

Each set was assigned a code number which was recorded on the report forms completed for each set. The code number was placed for identification purposes on the shunt regulator and rectifier tubes obtained when these tubes were replaced in the set. To facilitate survey scheduling with the appropriate manufacturer's or retailer's service representative and data tabulation, receivers were grouped as follows: (1) as sets made and sold under one manufacturer's name or (2) as sets sold under one or more brand names produced by one or more manufacturers.

The objectives of the survey were:

1. To obtain X-ray emission data on a variety of makes and models of color television sets operating in the Washington area.
2. To test procedures for and to determine the feasibility and usefulness of more representative and extensive surveys of color television receivers.
3. To provide information on possible sources of X-radiation which could be used by manufacturers or service organizations to prevent or correct excessive X-radiation emissions.

As a corollary to the survey, corrective service was provided for any set having X-radiation emissions in excess of the National Council on Radiation Protection and Measurements' recommendation "that the exposure rate at any readily accessible point 5 cm. from the surface of any home television receiver shall not exceed 0.5 mR per hour under normal operating conditions." (Ref. 2).

In the homes, X-radiation emission from surfaces of the set was measured, using a survey instrument developed by the National Center for Radiological Health. (Ref. 3). Prior to the survey of the receiver, the person interviewed in the home was requested to observe the picture and determine whether the receiver was operating in a condition as normally viewed. The X-radiation measurements were then recorded on the report under such home operating conditions. If X-radiation was detected, the set was adjusted to minimum brightness and then to maximum brightness so additional measurements could be made and recorded under those conditions. If the set, as measured by the instrument, was emitting X-radiation in excess of 0.5 mR/hr under home operating conditions, and if a radiographic film could be applied to the set, permission for radiographic film use was requested. Films were also placed on surfaces of a number of receivers measuring less than 0.5 mR/hr in order to secure film information for lower X-ray emission levels. The film was applied to the area of X-radiation emission located by the survey instrument. On some receivers, films were exposed on more than one surface. A timer was used to record the set operating times while 37 films were exposed. In 28 films where timers could not be used, the householders or the survey team kept a record of the exposure time.

Survey Instrument

The instruments used in the survey were designed and constructed expressly for the purpose of performing in-home measurements of X-radiation emissions from color television receivers. The radiation sensitive element of this instrument is an array of six Victoreen type 1B85 Geiger-Mueller tubes connected to a common high voltage supply. Individual solid state circuits measure the current through each detector. The outputs of the six read-out circuits are connected to the input of the meter circuit in such a manner that the meter indicates only the reading of the detector with the highest output. The circuitry provides the detection area of six Geiger-Mueller tubes and the background and calibration sensitivity of one tube. The large sensitive detection area provided by the six tubes allowed a surveyor to make a complete traverse of all set surfaces in ten minutes. The instrument was easily handled in any position with one hand. The location and approximate size of radiation beams could be estimated by depressing a switch which turned off all detector tubes except the end one. Survey instrument response was checked daily at the Electronic Products Radiation Laboratory prior to a survey team's departure. A Thulium 170 check source was moved the entire length of the instrument to check for the proper response of each of the six Geiger-Mueller tubes.

Calibration

For the purpose of the Washington survey, the survey instrument was calibrated with an X-radiation beam from a 6EF4 shunt regulator tube operated with 25 kVDC between cathode and anode which uniformly irradiated the entire 12.81 cm^2 (1.83 cm. by 7.0 cm.) cross-section of one Victoreen type 1B85 Geiger-Mueller detector at exposure rates between

0 and 12.5 mR/hr. The half-value layer of this X-ray beam was 0.50 mm of aluminum equivalent. The exposure-rates for the calibration X-ray beam were determined by a Victoreen model 440 RF Survey Meter the response of which had been found to be essentially independent of photon energy for X-rays from sources with accelerating voltages from 20 to 60 KVP and with first half-value layers (HVL's) of 0.40 to 2.00 mm of aluminum equivalent. This secondary system in turn had been calibrated by means of a General Electric Maximar 100 Self-Rectified therapy X-ray machine, and a Victoreen Type 326, 10 roentgen ionization chamber having National Bureau of Standards calibration for lightly filtered X-rays (Ref. 4). With the Geiger Mueller survey instrument, the same meter response will result from an exposure rate of approximately 6.5 mR/hr over an area of 1 cm² or approximately 650 mR/hr over 0.01 cm² (1 mm by 1 mm) of the instrument detector. The instrument response does not require an area correction if the X-ray beam uniformly and completely irradiates one or more of the detectors. The survey protocol was developed to provide a reasonable interpretation of the National Council on Radiation Protection and Measurements' recommendation. The "exposure rate at any readily accessible point" was interpreted as the exposure rate averaged over the 13 square centimeter sensitive area of a single Geiger-Mueller tube, the smallest area measurable by available instrument components meeting the other requirements for use in the home survey.

Film

When the survey instrumentation indicated X-radiation exposure rates above 0.5 mR/hr, or when lower X-radiation emissions were to be studied and permission was given by the owner, radiographic film techniques were used as a supplementary survey technique. Permission was generally given for use of film on any side except over the picture tube. In some instances, the team leader made the judgment not to use the film because (1) long exposure times were necessary or (2) it was determined exposure time for the film could not be accurately recorded. In some cases the film could not be exposed because the film pack would have covered ventilation holes for an excessive length of time, possibly resulting in an overheating of the receiver. The film pack technique provided additional documentation on the size, shape, and possible source of the X-radiation emission as well as an additional measurement of exposure rate.

The film was placed against the surface of the set covering the area of highest survey instrument reading for the receiver. The film was held in position with masking tape in direct contact with the cabinet. The advantage of the attachment procedure was that it was convenient and did not damage the receiver. In most cases, the correction of X-ray exposure rates for placement of the film against the set instead of at 5 cm. from set surface was insignificant. In most cases an elapsed time meter was used to measure the total number of hours of operation of the set during the film exposure. The timer was connected in series between the wall socket and the television receiver. No internal connections were required to the set and the timer did not affect the operation of the receiver in any way. The set could be used normally throughout the test period, which

frequently amounted to several days. The timer was accurate within the limits of line frequency and could be read to 0.1 minute. The survey instrument averaged the X-radiation over an area of 13 cm^2 and might not have properly recorded the location of a small intense beam of X-radiation. Therefore, in some cases the film may not have covered the surface where the most intense exposure occurred. The film dosimetry packs contained two $14" \times 17"$ films, one of high sensitivity (Kodak Type KK) for recording low radiation exposures, (10 mR to 200 mR) and the other of a lower sensitivity (Kodak Commercial) (50 mR to 60,000 mR) for recording higher exposures. These two films exhibit a satisfactory degree of overlap from 50 mR to 200 mR. The range of measurable X-radiation exposures for the combined package is from approximately 10 mR to over 60,000 mR. Film energy dependence for X-radiation expected from components operated in the observed high voltage range may result in an underestimate or overestimate of the true exposure rate by a factor of two. The highest exposure rate recorded by film during the survey was about 369 mR/hr. Since the X-radiation exposure recorded on some of the sensitive films was more than 200 mR, it was necessary to obtain optical density measurements from the commercial film. The more sensitive KK film was always placed closest to the TV receiver, the same position relative to the source of X-radiation used in the film calibration procedure. Instrument measurements of exposure rate were used to estimate the minimum time required to produce an exposure of 10 mR, the lower limit for optical density measurements on the film.

The exposed films were opened and loaded into a multiple film developing rack in complete darkness. They were then developed in fresh Kodak Rapid X-ray developer for five minutes at 20°C . During development the films were agitated every 25 seconds by two-second bursts of nitrogen bubbles.

After development was complete, the films were placed in Kodak Liquid Stop Bath for one minute and then fixed for ten minutes in Kodak X-ray Fixer. The films were then washed for 30 minutes in clear running tap water, dipped in Kodak Photo-Flo solution for one minute and dried in a hot-air drying chamber (Ref. 6).

The gross optical densities of the films were determined by using a MacBeth Ansco Densitometer, Model 12A, Serial No. 1350 with a 4 mm diameter light beam aperture. The densitometer was calibrated for an optical density range of 0.00 to 4.00 using the manufacturer's step wedge. Each gross optical density was converted to net optical density by subtracting a background fog and base density, determined from unexposed control films.

The conversion of net optical density units to X-ray exposure rate in terms of mR/hr is based on a table of values obtained for the National X-ray Exposure Study (Ref. 7). The conversion from net optical density to X-ray exposure is done in two steps. First, all densities are converted to the exposure that would have been required from cobalt-60 gamma rays. The cobalt-60 equivalent exposure is then converted to X-ray exposure by multiplying the former by 0.15, an average energy dependence factor for X-radiation that has a first half-value layer of 0.5 mm of aluminum. The reported film exposure rates are those calculated from the maximum net optical density measurement on the film within the optical density calibration range for the film used, either KK or commercial.

The geometry, uniformity, and quality of the X-radiation beam can produce significant differences between film and survey instrument exposure rate results. Recorded film exposure rates were based on the optical density

at the point (4 mm diameter) of highest density on the film. Film exposure readings averaged over an area more nearly approximating the sensitive area of the instrument would be expected to give exposure rates comparable to the survey instrument readings when all other factors are equal.

The Geiger-Mueller survey instrument responds to the average X-radiation intensity over a rectangle approximately 7.0 cm by 1.8 cm. If the field intensity is not uniform over this rectangle (as in the case for most films), the Geiger-Mueller survey instrument will probably indicate a lower value than the film.

Data Collection and Analysis

In addition to the X-ray emission levels measured for each set, estimates of the area of the X-radiation field and location of the center of the field on the set surfaces were entered on the survey report form. Information concerning the date of purchase and whether or not the set had been recently serviced was obtained from the receiver owner and recorded.

If a film pack was utilized, the film report form was completed. The location on the set and exposure start and stop times were entered on the film instruction form attached to each film pack. If a film pack was utilized, the receiver code number, the location on the set, the exposure start and stop times were recorded on a form attached to each film pack.

Limited information on viewing habits was obtained through discussion with household members while the survey measurements were being made. The formal interview technique was not employed so as to avoid extension of the time required for the home visits.

State and local health or other agencies interested in conducting surveys of their own may obtain additional information concerning procedures, forms and instrumentation used in the Washington Metropolitan area survey by writing the National Center for Radiological Health, 12720 Twinbrook Parkway, Rockville, Maryland 20852.

RESULTS

X-Radiation Emissions

Some X-radiation emission was detectable from a variety of makes and models of 1,124 color television receivers surveyed (see Table I). Table II gives the distribution of color TV receivers by the highest X-radiation exposure rates as measured by the NCRH survey instrument under home operating conditions. X-radiation emissions were not detected on 856 receivers. Exposure rates at or above 0.04 mR/hr were recorded for 268 receivers, with 202 of the 268 showing X-ray emissions of between 0.04 mR/hr and 0.5 mR/hr. Thus, 1,058 sets were within the recommendation of the National Council on Radiation Protection and Measurements, as interpreted for purposes of this survey. Of the 66 sets having X-radiation levels at or above 0.5 mR/hr, 40 indicated levels at or above 1.0 mR/hr, and 2 sets exceeded 12.5 mR/hr, the full scale reading of the survey instrument.

For the 268 sets at or above 0.04 mR/hr, X-radiation emissions were observed on six sides of ten receivers, on five sides of 18 receivers, on four sides of 22 receivers, on three sides of 32 receivers, on two sides of 57 receivers, and on one side of 129 receivers. Sixty-eight surveys measured the highest X-radiation levels at the left, 74 at the back of the television set, and 54 measured the highest level at the

front. Over 20 percent of the sets with levels greater than 0.04 mR/hr had the highest X-radiation emission from the front.

Of the 66 sets exceeding the 0.5 mR/hr reading, X-radiation emissions were detected on six sides of seven receivers, on five sides of eight receivers, on four sides of nine receivers, on three sides of twelve receivers, on two sides of sixteen receivers, and on one side of fourteen receivers.

Table III shows the location of the highest X-radiation level measured on the sets above the instrument's lower detection limit of 0.04 mR/hr. For the 66 sets equal to or exceeding 0.5 mR/hr, the location of the highest level measured was as follows: Bottom - 11, Left (of viewer) - 20, Top - 2, Front - 12, Right (of viewer) - 1, and Back - 20.

In the survey, 70 film packs were exposed on 55 receivers, 45 of which were found with X-radiation emissions at or above 0.5 mR/hr by the survey instrument. Exposure rates measured by the radiographic film technique ranged from 0.12 to 369 mR/hr as shown in Table VI.

Observed Operating Parameters

The survey provided data on line voltage and operating high voltage because of the importance of these parameters in the production of X-radiation (Ref. 5). These measurements were made by the manufacturers' representatives in the home. The line voltage measured ranged from 107 volts to 129 volts. The line voltage observed most often was 120 volts. The operating high voltage of a receiver can vary with line voltage depending on the degree of regulation provided by the circuit design.

The maximum variation in line voltage could produce a 20% change in the operating high voltage of a receiver.

Table IV shows the operating high voltage measurements on 808 receivers and the X-radiation emissions from these sets by high voltage intervals of 1 kV over the observed range of 18 kV to 34 kV. Some sets operating well below the observed average high voltage level emitted excessive X-radiation. However, as theory suggests, there is a general increase in the proportion of sets exceeding the 0.5 mR/hr X-radiation exposure rate as operating voltages increase.

Comparison of Measurements

Comparison of film pack and survey instrument measurements of X-radiation exposure rates are shown in Table VI. For 70 films, 58 valid comparisons could be made with survey instrument measurements of exposure rate. The film gave higher values than the instrument in 48 comparisons, lower values in 10 cases.

Factors Affecting X-radiation Emission

The basic receiver designs identified in the survey can be classed as circuit designs with or without high voltage shunt regulator tubes. High voltage measurements were made by manufacturers' representatives and properly recorded on the report form on 226 out of the 268 sets found to be emitting X-radiation at or above 0.04 mR/hr.

The average observed high voltage for the 181 receivers with a shunt regulator tube, producing X-radiation at or above 0.04 mR/hr was 25.8 kV; the average rated voltage for these receivers was 24.4 kV. Eighty-two of the 181 receivers exceeded 26.5 kV.

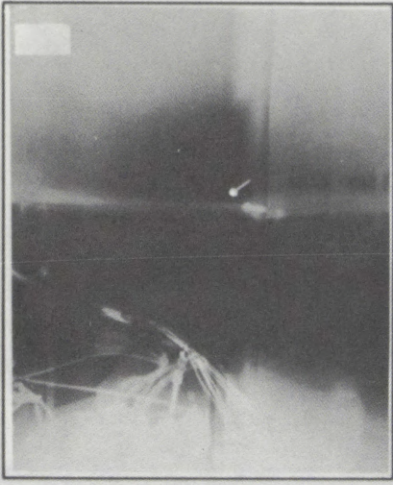
For the 45 receivers not having a shunt regulator tube and producing measurable X-radiation, 27 had a high voltage reading above 27 kV which was the average value observed for such receivers. Table VII gives the distribution of the X-radiation exposure estimate measured for the year of purchase. Detectable X-radiation was observed regardless of the age of the sets. The survey did not provide detailed information on the amount of servicing, including replacement of components. A service adjustment within the 2-month period prior to the survey was reported for 24 of the 66 sets with exposure rates above 0.5 mR/hr. The average operating voltage for these 24 sets was 27.5 kV.

Source of X-radiation

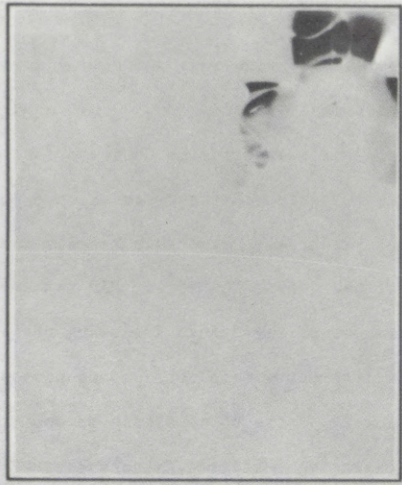
The probable sources of X-radiation were determined from a review of the instrument measurements and the patterns formed on film. Figure 1 shows four patterns typical of exposed film packs. The probable primary sources of X-radiation emissions were identified as the high voltage shunt regulator tube, the high voltage rectifier tube, and the picture tube. In the 55 sets studied with film, the shunt regulator tube was identified as the probable primary source in 30 of the receivers, the picture tube in nine, a combination of the shunt regulator and picture tube in six, and the rectifier tube in eight other receivers. In two sets, no specific source could be identified.

Corrective Servicing

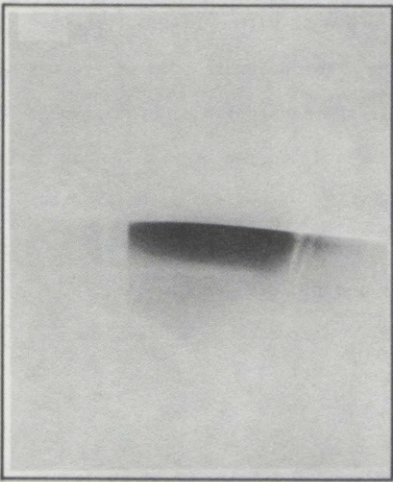
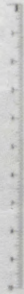
Each receiver with X-radiation emission above 0.5 mR/hr was serviced by the manufacturer's representative by replacing components and/or adjusting the operating high voltage to the recommended operating level. The set was then resurveyed for X-radiation emission to ensure that the corrective servicing had reduced the level below 0.5 mR/hr. The high voltage was



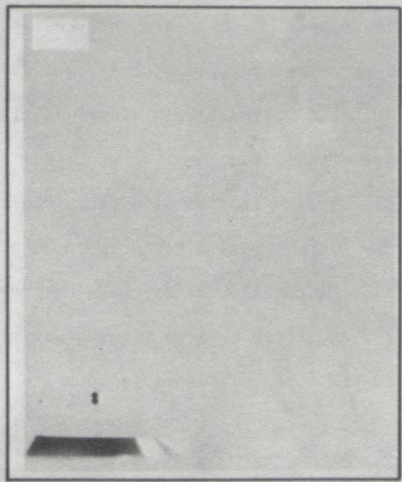
A. High exposure rate from multiple sources, picture tube, and shunt regulator.



B. Pattern of bottom emission from a shunt regulator tube.



C. A typical pattern from multiple sources.



D. Back pattern from a shunt regulator tube.

Figure 1 Photographs of Radiographic films exposed to X radiation from color television receiver

set to the value recommended by the manufacturer's representative for the line voltages as measured at the time of survey.

In one case the corrective servicing included the adjustment of high voltage, replacement of a tube, and the addition of shielding. The adjustment in operating high voltage and replacement of the shunt regulator tube reduced the X-radiation exposure rate below 0.5 mR/hr. It was not possible to detect any X-radiation from the set with the addition of shielding around the high voltage cage.

The servicing adjustments included 29 tube replacements for 27 of the 66 sets at or above 0.5 mR/hr. Two rectifier tubes type 3A3A were replaced. Twenty-seven shunt regulator tubes of type 6BK4, 6BK4A, or 6BK4B were replaced. For 36 of the 66 sets above 0.5 mR/hr, high voltage adjustments alone reduced radiation to 0.5 mR/hr or lower as measured by the survey instrument. Three receivers did not have a service adjustment recorded.

Exposure Parameters in the Home

The survey provided some data on viewing habits (Table V) of 2,311 individuals in 741 households: 743 household members viewed television from less than eight feet. Three hundred and eighty persons stated they viewed color sets in excess of 30 hours per week. Approximately 20 percent of the individuals under 15 years of age view color television more than 30 hours per week. Information stated by the person interviewed in the home indicated 328 of 547 viewers under age 15 view television at less than eight feet and 48 at distances under four feet.

DISCUSSION

The survey demonstrated that the industry is capable of producing sets which do not emit excessive amounts of X-radiation. More than three-fourths of the sets surveyed showed no detectable X-radiation emission in spite of the fact that the instrumentation could record X-radiation at levels approximately twice the normal radiation background in homes.

The survey was developed for the purpose of determining whether the color television X-ray emission problem was of an industry-wide nature or limited to only one manufacturer. While an attempt was made to obtain data on a variety of make and model sets, the sampling was limited to a single major metropolitan area and adequate representation of any one make or model set was not intended. In fact, the sampling of receivers was so small that only one set was surveyed in some instances. Consequently, data for the entire sample of sets was considered in evaluating the survey results.

Some consolidation and grouping of the receivers was required for tabulation of data and to encourage industry participation in the survey. Industry representatives were interested in participating in the survey, where sets they manufactured or distributed were involved. The grouping of sets facilitated servicing and technical assistance support both from the distributor's and manufacturer's representatives. In some cases, sets are identified to the public only in terms of the brand name of the retail distributors and direct association with a particular manufacturer could only be determined by an inspection and precise identification of the set by model and serial number.

If a brand name survey is desirable, the population of sets selected would have to be statistically representative of the entire industry, both in terms of numbers and geographical distribution. It should also reflect the current as well as the accumulative production of each of the selected manufacturers or brands. Furthermore, within this total population the sample of each brand name would, of necessity, have to be sufficiently large to represent the brand adequately including the specific models and types which could be expected to be significantly different from the standpoint of X-radiation production. In addition, such factors as interchange of components by the manufacturer, interchange of components at the servicing level, and the servicing of a number of brands by a single organization or serviceman, must be clearly identifiable before an evaluation of X-radiation emissions can be made by brand names.

The basic designs of receiver chassis, and the chassis-cabinet combination or model, strongly influenced the observed X-ray conditions. Sets operating at lower picture tube voltages (i.e., 17 to 23 kV) had definitely lower X-ray emission rates than those sets operating at higher kilovoltages. Sets with shunt regulator tubes seemed to have an increased probability of excessive X-radiation emissions. However, proper shielding of high voltage components, either shunt regulator or rectifier tubes, can reduce the probability of X-radiation emission.

The sets as surveyed consisted of some combinations of the original assemblies and replacement components from a variety of sources. The condition of the set at the time of measurement also reflected the servicing carried out by individual manufacturers' representatives, distributors, and independent servicemen.

Survey results confirmed the theoretical and experimental information on the sensitivity of X-radiation production to changes in operating high voltage of receivers. Elevation of operating high voltage settings above rated voltage levels was associated with increased X-radiation emissions; similarly, during corrective servicing decreases in high voltage reduced X-radiation emissions.

It should be noted, however, that some sets operating at levels of 21 kV still emitted excessive X-radiation. This occurred even though the survey instrument tended to record values below the true emission rate at this energy level. Thus all excessive emissions cannot be explained by voltage settings. On the other hand, some of the excessive emissions recorded in the higher operating voltage range are probably due to voltage adjustments and the tendency to record X-radiation emission rates above the true value in this energy range. The degree of change of the instrument reading could only be calculated with precision if some determination of beam quality, such as half-value layers (HVL), could be obtained in the home. However, assuming that a maximum correction factor of 3 for the higher energy levels is applied, excessive X-radiation emissions would still be recorded. The film data indicates more precise definition of the area of the beam and would

generally increase the number of excessive emissions. With the variety of sources, shielding, and beam size further development work is necessary for more precise instrumentation.

CONCLUSIONS

1. Some X-radiation emission was observed in a variety of makes and models of the 1,124 receivers surveyed in the Washington Metropolitan Area.
2. One of the most important findings of the survey is that 856 of the 1,124 receivers surveyed emitted no measurable levels of X-radiation. The survey results demonstrate that the industry has produced color television sets that can be operated well within the National Council on Radiation Protection and Measurements' recommendation and in most instances with X-radiation emission levels approaching normal background radiation in homes.
3. The primary sources of X-ray emissions are (1) the high voltage shunt regulator tube, (2) the high voltage rectifier tube, and (3) the picture tube.
4. The operating high voltage for television receivers demonstrably affects production and emission of X-radiation from components.
5. It is possible to reduce X-radiation emissions through service adjustments, including replacement of shunt regulator or high voltage rectifier tubes, and reduction of the operating high voltage.
6. The survey technique did not provide data to support a valid association of observed X-radiation conditions with individual brand name or manufacturer on a nationwide basis.

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APPENDIX

TABLE I

X-RADIATION EMISSION FROM
COLOR TELEVISION RECEIVERS

<u>GROUP*</u>	<u>SETS SURVEYED</u>	<u>SETS WITH X-RADIATION AT OR ABOVE 0.04 mR/hr</u>	<u>SETS WITH X-RADIATION AT OR ABOVE 0.5 mR/hr</u>
A	360	78	20
B	162	58	19
C	100	7	0
D	75	32	4
E	72	5	0
F	71	18	1
G	69	23	10
H	45	3	0
I	33	13	1
J	30	5	0
K	19	1	0
L	18	1	0
M	16	0	0
N	15	3	1
O	13	13	8
P	7	3	0
Q	6	1	0
R	4	0	0
S	2	2	1
T	2	2	1
U	2	0	0
V	1	0	0
W	1	0	0
X	<u>1</u>	<u>0</u>	<u>0</u>
TOTAL	1,124	268	66

* Some standardization of terminology and grouping of sets was essential for tabulation and interpretation of results by manufacturer, brand name, distributor, or retailer dealer. The term "brand" can be related to the manufacturer or the name under which the set is marketed.

TABLE II

DISTRIBUTION OF COLOR TV RECEIVERS
BY THE X-RADIATION EXPOSURE RATE

<u>X-RADIATION EXPOSURE RATE mR/hr</u>	<u>NUMBER RECEIVERS IN RANGE</u>
< 0.040	856
0.040 - 0.074	52
0.075 - 0.124	38
0.125 - 0.249	68
0.250 - 0.499	44
0.500 - 0.999	26
1.000 - 1.999	23
2.000 - 3.749	5
3.750 - 7.499	5
7.500 -12.499	5
> 12.500	2

TOTAL SETS - 1,124

TABLE III
LOCATION OF MAXIMUM X-RADIATION EXPOSURE RATES
ON HOME COLOR TV RECEIVERS

X-radiation Exposure Rates mR/hr	Number of Sets by Location of the Highest Exposure Rate Measurement*						Total
	Bottom	Left	Top	Front	Right	Back	
0.040 - 0.074	8	7	12	14	0	11	52
0.075 - 0.124	6	4	9	11	0	8	38
0.125 - 0.249	2	23	14	9	0	20	68
0.250 - 0.499	2	14	4	8	1	15	44
0.500 - 0.999	6	7	2	3	1	7	26
1.000 - 1.999	3	6	0	5	0	9	23
2.000 - 3.749	0	2	0	1	0	2	5
3.750 - 7.499	0	2	0	2	0	1	5
7.500 -12.499	1	2	0	1	0	1	5
> 12.500	1	1	0	0	0	0	2
TOTAL	29	68	41	54	2	74	268

* A number of sets had the same exposure-rate on more than one side. The priority for placement in the table is the following: front, left, top, back, bottom, and right. "Left" is the set surface on the viewer's left.

TABLE IV
NUMBERS OF COLOR TV RECEIVERS BY X-RADIATION
EXPOSURE RATE AND OPERATING HIGH VOLTAGE

X-radiation Exposure Rate mR/hr	Operating High Voltage (kilovolts)																TOTAL
	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
< 0.040	47	14	18	27	46	73	90	121	83	39	16	6	1	1	0		582
0.040 - 0.074	0	0	1	0	2	4	6	6	10	6	5	0	0	0	0		40
0.075 - 0.124	0	0	0	1	2	1	3	3	5	10	5	0	1	1	0		32
0.125 - 0.249	0	0	0	2	7	7	7	7	8	7	5	5	0	0	0		55
0.250 - 0.499	0	0	0	2	3	0	3	7	3	6	6	4	2	0	0		36
0.500 - 0.999	0	0	0	1	0	3	4	4	3	4	4	1	0	1	1		26
1.000 - 1.999	0	0	0	0	0	1	3	5	4	2	0	2	1	3	0		21
2.000 - 3.749	0	0	0	0	0	0	0	2	1	0	0	0	1	0	0	1	5
3.750 - 7.499	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	4
7.500 - 12.500	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	0	5
> 12.50	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	2
TOTALS	47	14	19	33	60	89	116	156	119	76	42	18	8	7	1	1	2 808*
% exceeding 0.5 mR/hr	0	0	0	3.0	0	4.5	6.0	7.7	8.4	10.5	11.9	16.7	50.0	71.4	100.0	100.0	100.0

* Operating high voltage measurements were not made on 316 receivers. Three of these receivers had radiation emissions above 0.5 mR/hr.

TABLE V
Household Members by Age, by Normal Viewing Distance and Hours Per Week Viewing Time

	TOTAL	UNDER 4 FT.	DISTANCE IN FEET			12-15 FT.	16 FT.	NOT INDICATED
			4-7 FT.	8-11 FT.				
All Ages (Years)	2,311	84	659	969	484	71	44	
Hours Per Week			(Number of Persons)					
15 and under	1,061	49	290	442	225	39	16	
16-30	345	24	239	376	179	19	8	
31	380	11	127	148	78	13	3	
Not Indicated	25	0	3	3	2	0	17	
Under 15 Years Old	547	48	280	150	39	6	24	
Hours Per Week								
15 and under	198	22	100	53	10	5	8	
16-30	219	18	104	64	25	1	7	
31	120	8	74	33	4	0	1	
Not Indicated	10	0	2	0	0	0	8	
15-44 Years Old	1,049	23	232	497	255	39	12	
Hours Per Week								
15 and under	536	16	123	242	134	14	7	
16-30	360	5	78	189	79	8	1	
31	149	2	30	65	42	3	2	
Not Indicated	4	0	1	1	0	0	2	
45 Years Old and Over	715	13	147	322	190	35	9	
Hours Per Week								
45 and under	327	11	67	147	81	20	1	
16-30	266	1	57	123	75	10	0	
31	111	1	23	50	32	5	0	
Not Indicated	11	0	0	2	2	0	7	

TABLE VI

X-RADIATION EMISSION LEVELS FROM COLOR TELEVISION RECEIVERS
 BY LOCATION, PROBABLE SOURCE AND OPERATING KILOVOLTAGE
 BASED ON SURVEY INSTRUMENTATION AND RADIOGRAPHIC FILM MEASUREMENTS

Receiver Case Number ¹	Receiver Operating Voltage (kV)	Probable Source of X-radiation	Location Film on Receiver	Time of Film Exposure (hr)	X-radiation Expo- sure Rates in mR/hr	
					Film	Instrument
1a	-	Picture ²	Left	61.40	0.12	0.10
1b	-	Picture	Right	61.40	0.13	0.11
1c	-	Picture	Top	61.40	0.15	0.11
2	27.6	Rectifier	Bottom	30.50	0.14	1.10
3a	-	-	Back	(29.00) ³	0.15	0.14
3b	-	-	Back	(29.00)	0.22	0.14
4	27.0	Rectifier	Back	(78.00)	0.17	0.19
5	29.0	Shunt or Rectifier	Left	28.40	0.17	0.62
6	24.0	Picture	Top	(60.00)	0.20	0.28
7	28.5	Picture	Back	49.50	0.22	0.60
8	-	Picture	Top	55.50	0.33	0.10
9	25.5	Rectifier	Left	64.50	0.36	0.21
10	23.8	Picture	Back	43.20	0.43	0.83
11	27.0	Rectifier	Back	23.00	0.43	0.10
12	26.5	Rectifier	Left	30.50	0.44	0.19
13	24.5	Rectifier	Back	(43.00)	0.52	0.19
14a	25.0	Shunt	Left	(27.50)	0.80	0.50
14b	25.0	Shunt	Back	(8.00)	3.65	3.25
15	31.0	Shunt	Back	24.80	0.90	1.10

TABLE VI

- 2 -

Receiver Case Number	Receiver Operating Voltage (kV)	Probable Source of X-radiation	Location Film on Receiver	Time of Film Exposure (hr)	X-radiation Expo- sure Rates in mR/hr	
					Film	Instrument
16	26.0	Shunt	Bottom	(63.50)	0.92	0.88
17a	30.5	Shunt & Pict.	Top	61.30	1.20	2.25
17b	30.5	Shunt & Pict.	Left	61.30	3.17	2.25
17c	30.5	Shunt & Pict.	Back	61.30	12.80	7.50
18	29.0	Shunt	Left	27.50	1.34	0.65
19	30.5	Picture	Left	(10.00)	1.40	2.25
20	26.8	Shunt	Left	(35.00)	1.50	0.20
21a	25.0	Shunt	Back	(49.00)	1.60	1.50
21b	25.0	Shunt	Left	(49.00)	2.38	0.30
22	25.0	Shunt	Front	85.00	1.76	0.63
23	25.5	Rectifier	Left	(65.50)	1.84	1.00
24a	30.0	Picture	Top	5.08	1.92	1.25
24b	30.0	Shunt & Pict.	Back	5.08	94.50	>12.50
24c	30.0	Shunt & Pict.	Back	5.08	181.00	>12.50
25	27.0	Shunt	Back	(133.00)	2.03	1.40
26	27.0	Shunt	Back	(22.30)	2.06	1.50
27	34.0	Picture	Front	(5.25)	2.54	5.00
28	25.0	Shunt	Left	(64.00)	2.50	1.10
29	33.5	Shunt	Back	5.97	3.10	2.50
30	25.1	Shunt	Left	(12.50)	3.50	1.10
31a	26.5	Shunt & Pict.	Back	(13.50)	3.63	0.88
31b	26.5	Shunt & Pict.	Left	(13.50)	4.23	1.12
32	24.0	Shunt	Back	51.60	4.09	1.62

TABLE VI

-3-

Receiver Case 1 Number	Receiver Operating Voltage (kV)	Probable Source of X-radiation	Location Film on Receiver	Time of Film Exposure (hr)	X-radiation Expo- sure Rates in mR/hr	
					Film	Instrument
33	24.2	Shunt	Back	(17.00)	4.60	0.75
34	26.5	Shunt	Back	22.50	5.80	1.00
35	26.0	Shunt	Back	8.10	6.30	1.10
36	26.2	Shunt	Back	5.50	7.61	2.50
37	25.5	Shunt	Left	(4.00)	7.61	2.60
38	26.0	Shunt	Bottom	24.00	9.81	0.81
39	25.5	Shunt	Left	(8.50)	10.60	3.75
40	24.1	Shunt	Back	(27.60)	11.40	1.10
41	31.0	Shunt & Pict.	Left	(21.00)	24.40	11.20
42	27.0	Shunt	Left	(6.33)	29.50	3.75
43	28.5	Shunt	Left	11.00	47.40	10.00
44	23.5	Shunt	Back	13.90	51.00	1.25
45	26.2	Shunt	Bottom	9.58	89.20	8.80
46	23.0	Shunt	Left	0.19	97.10	0.55
47	28.6	Shunt	Bottom	(1.85)	100.00	>12.50
48	26.0	Shunt	Bottom	(0.88)	369.00	>12.50
49a	29.0	Picture	Left	Exposure Time Not Recorded	-	0.40
49b	29.0	Picture	Top	Exposure Time Not Recorded	-	0.70
50a	31.0	Shunt & Pict.	Back	Exposure Time Not Recorded	-	1.25

TABLE VI

-4-

Receiver Case Number ¹	Receiver Operating Voltage (kV)	Probable Source X-radiation	Location Film on Receiver	Time of Film Exposure (hr)	X-radiation Exposure Rate in mR/hr	
					Film	Instrument
50b	31.0	Shunt & Pict.	Left	Exposure Time Not Recorded	-	1.50
51a	27.0	Picture	Back	Insufficient Exposure Time	-	0.50
51b	27.0	Picture	Top	Insufficient Exposure Time	-	0.51
51c	27.0	Picture	Right	Insufficient Exposure Time	-	0.53
51d	27.0	Picture	Left	Insufficient Exposure Time	-	0.53
52	24.5	-	Improperly Located Film	Insufficient Exposure Time	-	0.63
53	27.0	Rectifier	Left	Exposure Time Not Recorded	-	0.87
54	-	Picture	Front	Insufficient Exposure Time	-	1.10
55	27.5	Shunt	Left	Insufficient Exposure Time	-	4.20

1) Subscripts indicate where more than one film was used

2) Picture refers to picture tube

3) Exposure time estimated from record kept by set owner or by surveyor are shown in parentheses

TABLE VII
HIGHEST X-RADIATION EXPOSURE RATE FOR COLOR TV RECEIVERS
DISTRIBUTED BY DATE OF PURCHASE

X-radiation Exposure Rate mR/hr	Not Recorded	1955- 1962	1963	1964	1965	1966	1967	1968	TOTAL
< 0.040	31	34	16	45	103	240	385	2	856
0.040- 0.074		2		3	7	22	18		52
0.075- 0.124			2		7	14	15		38
0.125- 0.249	2	2	2	2	15	20	25		68
0.250- 0.499			1	2	14	14	13		44
0.500- 0.999	2		1	2	2	11	8		26
1.000- 1.999				3	7	7	6		23
2.000- 3.749						3	2		5
3.750- 7.499					1	1	3		5
7.500-12.499					1	4			5
> 12.500				1		1			2
TOTALS	35	38	22	58	157	337	475	2	1,124

Mr. ROGERS. If there are no other questions, we will leave the record open for 5 days, and the committee will stand adjourned.
(The following material was submitted for the record :)

ELECTRONIC INDUSTRIES ASSOCIATION,
Washington, D.C., February 7, 1968.

HON. JOHN JARMAN,
Chairman, Subcommittee on Public Health and Welfare, House Committee on Interstate and Foreign Commerce, Rayburn House Office Building, Washington, D.C.

DEAR MR. CHAIRMAN: At the hearing before your Subcommittee on February 1, 1968, on TV X-Radiation, Mr. James G. Terrill, Director of the National Center for Radiological Health, testified that there was no disagreement that he knew of between NCRH and the industry as to the test device to be used for measuring radiation from TV sets.

In order to make the record clear, I wish to state on behalf of the TV manufacturers that they have from the outset disagreed most emphatically with the reliance by the NCRH on the Geiger-Mueller instrument which they used in the Washington survey. This disagreement still exists.

In order to explain the reasons for our objection to reliance by NCRH upon the Geiger-Mueller instrument for measuring radiation from TV sets, I am enclosing the following:

Item 1. Copy of a letter dated January 9, 1968, from Mr. James D. Secrest, Executive Vice President of Electronic Industries Association to Mr. Terrill.

Item 2. Copy of a two-page memorandum dated January 9, 1968, which contains the comments of our industry on the NCRH instrument.

Item 3. Copy of a letter dated February 1, 1968, from me to Hon. Philip Lee, Assistant Secretary of Health, Education and Welfare.

We respectfully request that this letter and the said three enclosures be included in the record of the February 1 hearing.

Sincerely,

CHARLES N. HOFFMAN
(*Warwick Electronics*),
Chairman, Consumer Products Division.

ITEM 1

ELECTRONIC INDUSTRIES ASSOCIATION,
Washington, D.C., January 9, 1968.

Mr. JAMES G. TERRILL, Jr.,
Director, National Center for Radiological Health, Department of Health, Education, and Welfare, Public Health Service, Rockville, Md.

DEAR MR. TERRILL: In accordance with the discussions held on December 18, 1967 at the Rockville NCRH laboratory centered around your letter of October 31, 1967, we would like to summarize our reply as follows. The paragraphs are numbered corresponding to your letter of that date.

A. High voltage

The T.V. industry subscribes to the following philosophy expressed by Dr. William H. Stewart, Surgeon General, in his testimony on S2067 before the Senate Committee on Commerce hearing on August 29, 1967:

"For efficiency in obtaining compliance, the type of standard is important. Thus, I would prefer that, wherever possible, health protection standards be expressed as *performance* standards which would state, for example, what level of particular radiation emissions will be permitted at a defined distance from a television set rather than specifying in detail exactly *how* that requirement would be met. In contrast, rigid *specification* standards may become barriers to the adoption of technological innovations which might provide better health protection or equal health protection, more economically."

A.1 High voltage is only one factor in radiation from a television receiver. Rather than placing a limitation on high voltage, it is preferable to regard the overall receiver as a system in which the high voltage, the components, the shielding, and the circuits are engineered to meet the recommended system radiation performance standard. Arbitrary limitation of high voltage could restrict the de-

velopment and design of future non-radiating devices leading to a product of higher performance and better reliability.

A.2 Shielding also is but one factor in the over-all receiver system. It is the responsibility of the receiver designer to provide shielding which shall meet the radiation performance standard and which cannot readily be defeated by a careless serviceman. An interlock on a shield would not be foolproof because it could readily be defeated by a serviceman in the normal course of his work.

A.3 The high voltage adjustment control of a color television receiver is necessary to provide for the component tolerances and line voltage variations. Present circuits are being reviewed and modified to reduce the range of this control insofar as possible. Additional interim and longer range developments of dynamically-limited high voltage circuits are being investigated. This factor, like the two above, should best be regarded as part of the receiver system rather than as an individual radiation parameter.

B.1 We feel that the basic measurement factors are known by competent individuals within the governmental units and industry. Industry members are presently in agreement in the use of ionization chamber type instruments. Standardization efforts are well under way as shown by the following attachments:

JEDEC Publication No. 64, (Sept., 1967)

EIA Standards Proposal No. 975 (Dec. 26, 1967)

EIA Letter Ballot JTB-68-1 (Jan. 3, 1968)

As to agreement between industry and the governmental units, there is an apparent need to correlate the known information in developing acceptable procedures and instrumentation for measuring accurately the several potential radiation sources in a color receiver. Moreover, it is imperative that such agreement be reached before the release of survey data which might be misunderstood and misleading in the absence of this agreement.

We illustrate our concern in this matter by the following examples:

(a) The calibration of the PHS survey instruments used in the Washington survey was made for one particular spectral distribution of x-radiation. As has been shown in demonstrations at the NCRH Laboratory on December 21, 1967, this calibration was in error, resulting in readings which were high by a factor of 2:1 or 3:1 with other spectral distributions found in radiation from color television receivers. The known radiation spectra of the various x-radiation sources in television receivers and the voltage dependence of these spectra readily explain the error.

(b) Also, the calibration of two PHS survey instruments was observed to differ by 2:1 when compared on a fixed source of radiation in the field.

(c) Another area of disagreement lies in the use of time-peak readings with the PHS survey instruments rather than time-integrated readings.

Further observations on the Washington survey are presented in the attached "Comments on X-Radiation Measurements made by NCRH in the Washington Survey."

As a suggestion for resolving these and other discrepancies we propose a laboratory meeting at which PHS and industry technical representatives attempt to recalibrate the survey instruments, taking account of the now known energy distributions and other factors. Again, we emphasize the importance of doing this before the release of any survey results, as stated in the letter dated December 29, 1967 to you from Messrs. Armin C. Allen, and Charles M. Hoffman.

B.2 We are very much in favor of the proposed technical conference. In reply to your letter of December 29, 1967 on this subject, we are prepared to discuss this conference and are attaching a proposed agenda following your suggestions and including specific papers from industry experts.

C. Technical information dissemination

C.1 Our initial report to you on technical information releases has been updated on two occasions, and we are attaching copies of the following letters on the subject:

Letter from E. William Henry to James G. Terrill, Jr. Aug. 18, 1967

Letter from E. William Henry to James G. Terrill, Jr. Sept. 19, 1967

Letter from James D. Secrest to James G. Terrill, Dec. 29, 1967

C.2 It is our belief that the dissemination of technical service information is now adequate. However, if you should wish to hold a meeting to further explore this subject, we will be most happy to cooperate.

Cordially,

JAMES D. SECREST,
Executive Vice President.

ITEM 2

COMMENTS ON X-RADIATION MEASUREMENTS MADE BY NCRH IN THE WASHINGTON SURVEY

Several differences exist between NCRH measurements and generally-accepted scientific techniques and philosophy which cast doubt on the scientific validity of some of the measurements.

(1) It has been demonstrated on December 21, 1967 at the NCRH laboratory using NCRH instruments that their Geiger counter gives higher readings in mR/hr than their Victoreen RF 440 ionization chamber by a factor of 2 or 3. Specifically in the 25 to 30 kV range their aluminum window Geiger tube survey meter does not track their Victoreen ionization chamber when the applied voltage increases from 25 to 30 kV. As a specific example :

DATA TAKEN AT NCRH 12-21-67

[Measurements made on bottom beam of 6EF4 regulator tape]

Distance	Kilovolts	Milliamperes	Filter	NCRH 440RF No. 4 (mr./hr.)	NCRH GM survey meter ¹ (mr./hr.)	Ratio
3 meters.....	25	1	None	1.1	1.1	1.0
Do.....	30	1	2	1.4	3.8	3.5

By definition, 1 mr./hr. defined as 8,000 c.p.m. at all kilovolts from 25 to 34 kilovolts.

(2) The calibration of their instrument is valid only for downward radiation from a 6BK4 tube. Thus, it is for one kind of dose-contributing x-radiation, whereas television radiation has different spectral components from different sources and directions of observation (see (5) below). Thus the calibration is not necessarily valid at other energies because of the well-known energy-dependence of Geiger tubes.

(3) NCRH stated practice is to seek the highest instantaneous rate obtainable rather than a representative or average rate over a period of time. Thus measurements made in some home surveys with their instruments were not reproducible (because they measured transients) and cannot be used to calculate possible exposure dose.

(4) NCRH policy has been to use an energy-dependent instrument unavailable to the industry rather than a standard, recommended ionization instrument, upon which the definition of the roentgen is based. Thus, contrary to scientific practice and philosophy, their measurements are not subject to validation or reproducing in any other laboratory. The choice of this instrument for measurement is rather arbitrary, in fact. The following quotations are from "Principles of Radiation Dosimetry" by G. N. Whyte, Wiley (1959) :

1. "Of the secondary instruments in common use for the measurement of x-rays, cavity chambers have the advantage that they can be made to give readings most nearly proportional to exposure or absorbed dose, and they are generally employed when accurate measurements of these quantities are required."

2. "At lower energies the onset of the photoelectric effect causes the response to rise sharply, so that Geiger counters are of little use in the conventional x-ray region. Of course, when radiation of only a single energy (or a constant energy distribution) is involved, one can achieve accurate measurements by simply calibrating the counter specifically for this energy."

(5) Measurements made in some industrial laboratories have exposed several erroneous technical assertions made by NCRH. For example, on December 18 it was categorically stated by NCRH that the radiation from the 6BK4 contains no lead fluorescence and indeed the glass envelope contains no lead. Our measurements on domestic tubes show that all 6BK4 and 6EF4 tubes have lead-glass envelopes and emit large amounts of lead x-ray fluorescence and that the quality of the radiation (and therefore the validity of the measurement) varies considerably with voltage and direction of the radiation. This casts some doubt on the absolute authoritativeness of their measurements and techniques.

Similar remarks apply in some cases to the use of energy-dependent film in assaying the radiation level from television receivers.

Thus it has been established that in some cases the NCRH reading levels are high by a factor of at least 2 to 3. What has emerged is the use of a survey instrument and procedure which can detect radiation but not test compliance with NCRP recommendations except in extreme good and bad cases. This is especially important around the 0.5 mR/hr level.

We recognize the difficulties and complexities in the instrumentation and measurements of these small quantities of x-radiation. The industry would like to work with NCRP, NCRH, and NBS in working out the best practical way of determining compliance with NCRP. In testimony in hearings held on August 14, 1967, J. Terrill has stated that he thinks the ionization chamber (Victoreen RF 440) is the "most suitable device for measuring ionizing radiation qualitatively." Mr. Terrill also states: "We have to develop the standards of measurement not only in terms of devices, but also in terms of system of measurement." We recommend that the survey meter developed by NCRH be used for location purposes only, and that an ionization chamber device having none of the above-listed limitations be used for measurement under conditions concordant with good scientific practice.

ITEM 3

ELECTRONIC INDUSTRIES ASSOCIATION,
Washington, D.C., February 1, 1968.

Hon. PHILIP LEE,
Assistant Secretary,
Department of Health, Education, and Welfare,
Washington, D.C.

DEAR DR. LEE: We appreciate your courtesy in meeting with us for further discussion of the radiation problem.

In accordance with your suggestion we wish to formalize herewith our request for full details, including circuitry, of the Geiger-Mueller instrument used by NCRH in making the Washington survey. Needless to say we will provide any appropriate assurances which you may request to take care of patent considerations.

We enclose for your information a copy of the letter dated January 9, 1968 from Mr. Secrest to Mr. Terrill and a copy of the Electronic Industries Association memorandum of the same date which contains the comments of our industry on the NCRH instrument.

Sincerely,

CHARLES N. HOFFMAN
(Warwick Electronics, Inc.),
Chairman, Consumer Products Division,
Electronic Industries Association.

(Whereupon, at 11:25 a.m., the subcommittee was adjourned.)

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