MASTER

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PORTABLE RADIATION
SURVEY INSTRUMENTS

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by

R. G. Maras

Radiation Instrumentation

December 18, 1975

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PORTABLE RADIATION SURVEY INSTRUMENTS

The broad aspects of this title are somewhat frightening when organizing your thoughts about just what part of subject to report. The theme of this symposium however, narrows the field of considerations because this audience is more interested in the practical considerations of detectors and electronics and my development of the subject "Portable Radiation Survey Instruments" will give help, therefore, to the person who is interested in a review of instrument alternatives for radiometric measurements rather than a technical discussion of circuit analysis or detector physics.

First, a definition of "Portable Radiation Survey Instrument". Portable means that product is moveable and generally is hand carried or it could be fastened to a belt or placed in a pocket like a rule or a pack of cigarettes. Radiation means that it will detect alpha particles, beta particles, X and gamma rays and neutrons.

Instrument, for the purposes of this discourse is an electronic device for amplifying, processing and presenting information about the radiation measured.

Are the characteristics of a portable radiation survey instrument any different for example than a transistor radio or a flashlight

✓ a bull horn like used by police on TV shouting commands.

When you try to catagorize portable radiation survey instruments in relationship to all the other hand held or portable devices we work with you find a common road map in using the frequency spectrum to differentiate one portable survey instrument type in relationship to others.

What is really that much different between the concept of a hand held AM radio playing hard rock music to a scintillation alpha survey meter being used by a radiation monitor for contamination control?

Perhaps I can show the relationship I am talking about thru the use of a viewgraph of the frequency spectrum noting wherever possible man's use of that particular wavelength region and instrumentation that has helped quantify what is taking place.

What you now view is a graph showing frequency bands spread from ten to the tenth meters wavelength to ten to the minus fifteenth meters. Each band is characterized by its generic name or principal application of that wavelength region. Lets begin by talking about infrasonic which is a band of wavelengths from ten to the eleventh to ten to the seventh meters. In terms of frequency the midpoint of this wavelength band would be about one half cycle per second or more commonly one half hertz. To

ve indications of what these wavelengths look like . . . ten to the eleventh meters is the distance to the sun from the earth . . . ten to the ninth meters is the diameter of the sun . . . five times ten to the seventh is the distance to the moon . . . the distance represented by ten to the seventh meters is the diameter of the earth. Seismic exploration is in a frequency band of one to twenty Hertz or a wavelength centered about ten to the eighth meters. A geophone is a "Portable Device" and it consists of tremendous powerfull permanent magnet thru which is passed a coil of wire whose movement is governed by artificially produced shock waves. I know of no more portable device for sensing and defining infrasonic energy than the geophone used in geophysical exploration.

The sonic region is characterized by a wavelength band from ten to the seventh to a little less than ten to the fifth meters. This is what we hear! This is the range of the human voice. This is identified as high fidelity audio. A microphone is capable of detecting these wavelengths and converting them to electrical energy just like the geophone in the infrasonic region.

Ultrasonics, the next main category in the frequency spectrum lies between ten to the third and ten to the fifth meters wavelength. This is a corresponding frequency of 10 KHz to 200 KHz. A mile is a way of thinking of wavelengths in this region. The great network of VLF transmissions that are used for transmitting

~~/~~precise time and navigational locating signals are in this region. Sonar and ultrasonic cleaning are some principal applications of the frequencies here. Extractions wavelengths dipoles are the usual detectors and the processing electronics can be as compact as a modular hi-fi receiver. Transmitting ultrasonic energy is particularly complex as the propagation paths are lengthy, megawatts of power and transmitting antenna arrays that are placed on huge areas of land are common.

Lets just lump all the stuff going on between one hundred meters and a millimeter into one discussion area because this is the part of the frequency spectrum that is most familiar to all of us. It includes radio, television, radar and experimental. We know the general configuration of antennas as detectors here. Every-day of our lives we see or hear about receivers of this energy and have a grasp as to their size and circuit complexity. But since this is a meeting of health physics and we are interested in determining the presence of radiation to not only control contamination but to assess possible damage to man it is important to consider side effects that occur in this region covering five decades of wavelengths. Take for example diathermy principles of producing hyperthermia in flesh occurs at wave lengths of ten meters ... some bacteria cells are killed by 20 meter wavelength energy. The human nervous system is affected by energy of a meter. From a meter to 30 centimeters wavelength is where most

~~/~~ of the energy is absorbed by man with possible damage to internal organs heating due to the lack of heat sensation.

Ten centimeter wavelength energy is the focus of microwaves cooking. It is also the part of the frequency spectrum where eye damage from strong electromagnetic radiation is focused.

So beginning with the meter wavelength side effects produced by diathermy we are looking for types of detectors and instruments that would be the functional count-part of the portable survey instrument in ten to the minus tenth meter wavelength spectrum.... We find first the barretter or thermistor is a commonly used sensor that relies on the principal that excessive molecular resonance will cause a temperature change in a material carrying an electrical current and the induced heating is proportional to the intensity of the electromagnetic energy. And this is a good concept clear down to the millimeter wavelength energys. Rapid assessments stray energy leakage using a detector and simple electronics containing bridged circuitry to see small variations of direct current. And these then constitute the portable survey instrument for the energy band that is still a million times the wavelength of the part of the frequency spectrum we are most interested in.

What are portable survey instruments for infrared? Take for example a photograph of a flatiron that has been on electrical

heat with a special photographic film. A sniperscope behaves just like a telescope for visible light but with special filtering it is capable of seeing objects amongst foliage because its sensitive to the human body radiation in comparison to its surroundings. Aerial cameras using special filters and special film are mapping the earth looking for objects whose radiant energy release is different from the surroundings.

Ten to the minus seventh meters is one electron volt. Just in between the infrared and the visible region is the beginning of the electromagnetic wavelength that attracts the entire process of the instrumentation that we in this room are so familiar with. Six to 20 electron volts are what are required to produce ionization of most atoms ... 20 electron volts would be ten to the minus eight meters wavelength or just into the ultraviolet region. Photomultiplier tubes are often used for ultraviolet detection and they can be powered from batteries so it would be a very popular detector used with a portable survey instrument for this energy.

One kiloelectron volt is represented by the beginning of the X ray region at ten to the minus tenth meters this is also called soft X Ray region. The diameter of the largest atom is a little less than ten to the minus tenth meters.

Diameter of the smallest atom is ten to the minus eleventh meters which is about at the division point of soft to hard X rays.

Right in the middle of the band representing gamma is 1 MEV energy which is a little more than ten to the minus thirteenth meters wavelength. In this gamma region is represented most of the cancer research and nucleus structure studies.

Without the specific mention of the type detector or characteristics of different readouts I have presented a look at the most broadest aspects of defining a portable survey instrument so that it might take its proper place amongst all of the other instrumentation and devices that are used to detect energy. To specifically question why commercial manufacturers used a particular type readout of choice of battery or case configuration, or why did they use range changing when logarithmic performance would have been better or why was the detector placed inside the case rather than outside on a cable where it could be moved. There are many sales persons within earshot of what I am saying whose design experience and market knowledge far surpasses anything I could ever expect to poll . . .

You now have a better understanding of the relative role of the radiation survey meter to all of the other instrumentation that has been developed to detect electromagnetic energy.

FREQUENCY SPECTRUM

WAVELENGTH IN METERS

PHYSICS INSTRUMENTATION

Wednesday, February 11
Silver Room
11:00-12:00 Noon

QUANTITATIVE RESPIRATOR MAN-TESTING AT ROCKY FLATS

Jack D. Leigh
Rockwell International
Rocky Flats Plant
10683 Loren Lane
Northglenn, Colorado 80233

11:42-11:24 SIMULTANEOUS ALPHA-BETA COUNTING

P. M. Bramson, R. D. Glenn, and F. M. Cummings
Battelle-Northwest
318 Building, 300 Area
Richland, Washington 99352

11:24-11:36 EXPERIENCES IN ENVIRONMENTAL MONITORING WITH BeO CERAMIC DOSIMETERS

R. B. Gammage
Oak Ridge National Laboratory
P. O. Box X
Health Physics Division
Oak Ridge, Tennessee 37830

11:36-11:48 PERSONNEL PORTAL SCANNER

C. E. Nichols
Allied Chemical Corp.
550 Second Street
Idaho Falls, Idaho 83401

11:48-12:00 THE AMERICAN NATIONAL STANDARD CRITICALITY ACCIDENT ALARM SYSTEM

David R. Smith
MS 560, Los Alamos Scientific Laboratory
P. O. Box 1663
Los Alamos, New Mexico 87545

SHORT COURSE IV

Wednesday, February 11
Century Room
2:00-3:00 p.m.

NEUTRON MONITORING

Dale E. Hankins
University of California
Health and Safety Department
Los Alamos Scientific Laboratory
Los Alamos, New Mexico 87544

SHORT COURSE V

Wednesday, February 11
Spruce Room
2:00-3:00 p.m.

HEALTH PHYSICS PRACTICES AT MEDICAL ACCELERATORS

Gordon M. Kenney
Department of Radiology
Presbyterian Medical Center
1719 E. 19th Avenue
Denver, Colorado 80218

MICROWAVES

Wednesday, February 11
Silver Room
2:24-3:00 p.m.

2:24-2:36 THE MICROWAVE SAFETY PROGRAM AT THE NAVAL RESEARCH LABORATORY

Leroy F. Booth
Code 6073
Naval Research Laboratory
Washington, D.C. 20375

2:36-2:40 HIGH POWER RADIOFREQUENCY AND MICROWAVE RADIATION SOURCES: A STUDY

OF RELATIVE ENVIRONMENTAL SIGNIFICANCE
M. M. Hankin
U. S. Environmental Protection Agency
9100 Brookville Road
Silver Spring, Maryland 20910

2:40-3:00 A MOBILE RADIOFREQUENCY MEASUREMENT SYSTEM AND PRELIMINARY

ENVIRONMENTAL DATA
A. A. Tell, M. M. Hankin, J. C. Nelson, and D. E. Jones
U. S. Environmental Protection Agency
9100 Brookville Road
Silver Spring, Maryland 20910

SHORT COURSE I

Wednesday, February 11
Denver Room
11:00-12:00 Noon

PORTABLE RADIATION SURVEY INSTRUMENTS

Robert G. Maras
Rockwell International
Atomics International Division
Rocky Flats Plant
P. O. Box 464
Golden, Colorado 80401

SHORT COURSE II

Wednesday, February 11
Century Room
11:00-12:00 Noon

HEALTH PHYSICS PRACTICES AT RESEARCH ACCELERATORS

Ralph M. Thomas
Health Physics Department
Building 72
Lawrence Livermore Laboratory
University of California
Berkeley, California 94720

SHORT COURSE III

Wednesday, February 11
Denver Room
2:00-3:00 p.m.

EMERGENCY PLANNING

Jack M. Selby
Battelle-Northwest
P. O. Box 909
Richland, Washington 99352

and

Dade W. Moeller
Harvard School of Public Health
665 Huntington Avenue
Boston, Massachusetts 02113

MANAGEMENT AND REGULATIONS - HEALTH PHYSICS

Wednesday, February 11
Grand Ballroom
3:00-5:30 p.m.

3:00-3:15 PROBLEMS ENCOUNTERED IN ADMINISTERING A RADIATION PROTECTION

PROGRAM IN A RESEARCH ORIENTED ENVIRONMENT
George E. Joyce
U. S. Bureau of Mines
Department of Interior, Room 2609
1800 "C" Street, N.W.
Washington, D.C. 20240

3:15-3:30 RADIATION MONITORING CONSIDERATIONS FOR RADIOBIOLOGY FACILITIES

T. W. McClelland and F. D. McFall
Battelle-Northwest
300 Area/318 Building
Richland, Washington 99352

3:30-3:42 A RADIATION SAFETY PROGRAM FOR A NEW MEDICAL CENTER

Kenneth L. Miller
M-16B, Health Physics Office
Milton S. Hershey Medical Center
500 University Drive
Hershey, Pennsylvania 17033

3:42-3:54 A HEALTH PHYSICS MANAGEMENT PROGRAM FOR THE RECEIPT AND SHIPMENT

OF RADIOACTIVE MATERIALS
William A. Larson
TRW Systems/Hall Station RA-1020
One Space Park
Redondo Beach, California 90278

3:54-4:06 RADIATION EXPOSURE RECORDS MANAGEMENT

M. P. Bolter
Building 735-A
E. I. duPont Company
Savannah River Plant
Aiken, South Carolina 29801

4:06-4:18 COMPUTERIZED DOSE RECORDS KEEPING SYSTEM

Walter M. Muvitsky and Eldon D. Testa
39 Manser Road
Heffs, Pennsylvania 18065