GENERAL SCIENCE

Effects Of Radiation

National Academy of Sciences after year-long study of the biological effects of atomic radiation warns that any radiation is harmful to life and urges recording each exposure.

The following is the text of the brief digest of findings and recommendations contained in the National Academy of Sciences report to the public on "The Biological Effects of Atomic Radiation."

➤ IT IS GENERALLY agreed that, in the peacetime development of atomic energy, man has been lucky. He has been dealing with an enormous new force whose potential effects he has only dimly understood.

Thus far, except for some tragic accidents affecting small numbers of people, the biological damage from peacetime activities (including the testing of atomic weapons) has been essentially negligible. Furthermore, it appears that radiation problems, if they are met intelligently and vigilantly, need not stand in the way of the large-scale development of atomic energy.

The continuing need for intelligence and vigilance cannot be too strongly emphasized, however.

The problems of radiation fall naturally into two main classes: (1) the effects on human beings (2) the various ways in which radiation can reach human beings through the environment.

Effects on Humans

The inheritance mechanism is by far the most sensitive to radiation of any biological system. Any radiation which reaches the reproductive cells cause mutations (changes in the material governing heredity) that are passed on to succeeding generations.

Human gene mutations which produce observable effects are believed to be universally harmful.

Everyone is subjected to the natural background radiation which causes an unavoidable quantity of so-called spontaneous mutations. Anything that adds radiation to this naturally occurring background rate causes further mutations, and is genetically harmful.

There is no minimum amount of radiation which must be exceeded before mutations occur. Any amount, however small, that reaches the reproductive cells can cause a correspondingly small number of mutations. The more radiation, the more mutations.

The harm is cumulative. The genetic damage done by radiation builds up as the radiation is received, and depends on the total accumulated gonad dose received by people from their own conception to the conception of their last child.

So far as individuals are concerned, not all mutant genes or combinations of mutant genes are equally harmful. A few may cause very serious handicaps, many others may produce much smaller harm, or even no apparent damage.

But from the point of view of the total and eventual damage to the entire population, every mutation causes roughly the same amount of harm. This is because mutant genes can only disappear when the inheritance line in which they are carried dies out.

In cases of severe and obvious damage this may happen in the first generation; in other cases it may require hundreds of generations.

Thus, for the general population, and in the long run, a little radiation to a lot of people is as harmful as a lot of radiation to a few, since the total number of mutant genes can be the same in the two cases.

It is difficult to arrive at a figure showing how much genetic harm radiation can do. One measure is the amount of radiation above the natural background, which would produce as many mutations again as occur spontaneously. It is estimated that this amount is 30 to 80 roentgens.

(The roentgen is a unit of radiation. To give an idea of its value, the average dental X-ray delivers five roentgens to the patient's jaw, but only five thousandths of a roentgen of stray radiation to more remote parts of the body such as the gonads.)

It is also estimated that a dose of ten roentgens to every person in the United States would cause something on the orde of five million mutant genes which would then be a part of the population's inheritance pool. This figure is subject to considerable uncertainty.

At present the U. S. population is exposed to radiation from (a) the natural background, (b) medical and dental X-rays, (c) fall-out from atomic weapons testing The 30-year dose to the gonads received by the average person from each of these sources is estimated as follows:

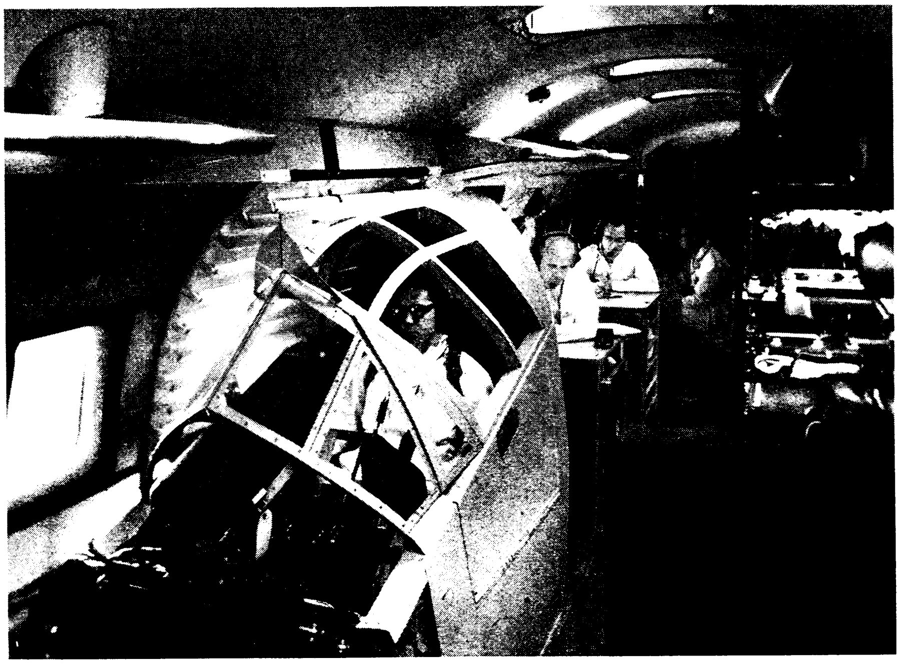
(a) background—about 4.3 roentgens

(b) X-rays and fluoroscopy—about 3 roentgens

(c) weapons tests—if continued at the rate of the past five years would give a probable 30-year dose at about 0.1 roentgens. This figure may be off by a factor of five, i.e., the possible range is from 0.02 to 0.5 roentgens. If tests were conducted at the rate of the two most active years (1953 and 1955) the 30-year dose would be about twice as great as that just stated.

If the exposure of the general population to radiation is limited to levels which the genetics committee believes reasonable (see

(Continued on page 390)



BACK SEAT FLYING—In a cockpit installed in the main cabin of a T-29 airliner, a second pilot takes over control of the airplane once the regular pilot has taken it aloft. Hughes Aircraft Company engineer R. E. Moore is shown in the "plane within a plane" where test pilots can fly as though they were in an F-102 jet interceptor while ten Hughes engineers can simultaneously check operation of the electronic control system.

Effects of Radiation

(Continued from page 387)

recommendations at the end of [article]), there should be practically no pathological effects in the persons receiving the radiation.

Larger exposures (say 100 roentgens and up) of the whole body or a large part of it are generally harmful. (Much higher doses may, however, be safely and usefully delivered to limited portions of the body under the controlled conditions of medical treatment.)

Very little is now known about how to treat the pathological effects of radiation or how to protect the body against them in the first place. Much research is needed in these fields.

One of the effects is a shortening of life. This seems to involve some generalized action. Irradiated individuals may age faster than normally even if they do not develop specific radiation-induced diseases like leukemia. It has not been shown that exposures small enough to be genetically tolerable have this effect. Furthermore, the permissible exposure levels that have been established for persons working with radiation appear to be within the limits of safety.

However, it is not yet known what minimum dose, if any, would be necessary to produce a statistically noticeable reduction of life span when very large numbers of people are concerned.

Environment and Food Supply

Radiation in the general environment has not yet become a serious problem. In a few decades, however, radioactive waste products from atomic power plants will represent an enormous potential source of contamination. How much of this radioactivity will actually reach the population depends on how successfully it can be kept out of the great network—ocean and air currents, food and water supplies—which connect man to his surroundings.

At present test explosions of atomic weapons are the only significant source of radiation in the general environment, above the natural background.

Meteorologists have found no evidence that atomic explosions have changed the weather or climate. Nor do they believe that continued weapons tests, at the same rate and in the same areas as in the past, would have such an effect. Radiation from explosions passes into the atmosphere and much of it eventually returns to the ground as "fall-out."

Fall-out divides into three classes: (1) close-in—material that comes down within a few hundred miles of the explosion and within 10 to 20 hours, (2) intermediate—material that descends in a few weeks after the explosion, (3) delayed—material that remains in the air for months or years.

Close-in fall-out from test explosions affects only restricted, uninhabited regions.

Intermediate fall-out would descend very slowly if it were pulled down only by gravity. It is mostly washed out of the air by rain and snow. It spreads over large parts of the earth, but its effect over a small area may be accentuated if there is heavy precipitation while the radioactive cloud is overhead.

Delayed fall-out is stored for long periods in the stratosphere. Meteorologists know very little about the interchange of air between the stratosphere and lower layers, so they cannot predict exactly how long the material will stay up, or where it is likely to descend.

At this point the oceans are not receiving any significant quantities of radioactive material. But eventually they will undoubtedly be used as a repository for some of the radioactive waste products of atomic power plants.

Oceanic Research Needed

Before this can safely begin on a large scale, much research is needed to determine the mixing rates between various parts of the seas. Materials deposited in some of the deep parts of the ocean may remain there 100 years or more, so that most of their radioactivity would be gone before they reach surface water.

On the other hand, material dumped into coastal and other surface waters would directly affect marine life and, within a few years, would contaminate all parts of the world because of the relatively rapid circulation of surface layers.

Radioactive tracers can be used to chart ocean and air currents and to study the interrelationships of marine animals. Many important experiments in these fields will be possible only within the next 10 or 20 years. Increasing radioactive contamination of the sea and atmosphere will make it impossible after that to detect the tracers against the heightened background.

Radiation from fall-out inevitably contaminates man's food supply. Radioactive elements in the soil are taken up and concentrated by plants. The plants may be eaten by humans, or by animals which in turn serve as human food.

Long-Term Effects Unknown

At present the contamination is negligible. But the maximum tolerable level is not known. There is not nearly enough information about the long-term biological effects on man or animals from eating radiation-contaminated food. Research in this area is urgently needed.

Probably the most important potential food contaminant is strontium 90—a radioactive element that concentrates in bone tissue. Already, detectable although biologically insignificant traces of it have turned up in milk supplies thousands of miles from the site of atomic explosions.

Food from the oceans is also subject to radioactive contamination. Marine plants and animals extract and concentrate various radioactive elements that get into sea water. The concentration is cumulative, increasing as it proceeds up the chain from microscopic plankton to edible fish.

Properly used, radiation can enhance man's food supply rather than damage it. Radiation techniques have already opened important new fields in agricultural research and will undoubtedly become increasingly valuable. No drastic change in agricultural production appears imminent, however.

Tracer studies will help us understand basic metabolic processes in plants and animals. They will also be applied to practical problems such as the use of fertilizers.

Mutation rates in plants are being artificially speeded up with radiation in the hope of producing new and superior strains. Thus far, only a few new economic varieties have been found, but the method is promising. The use of radiation to sterilize packaged food may have dramatic impact on food technology by reducing the need for refrigeration and extending the shelf-life of many products.

Holding radiation to a tolerable world-wide level will require adequate methods for disposing of, or, rather, for containing radioactive wastes from power reactors.

Some of these wastes will remain dangerously radioactive for centuries.

Research has indicated some apparently feasible systems for controlled disposal, but none is yet at the point of economic operating reality.

Routine Disposal Problem

The major problem in routine disposal is what to do with the wastes resulting from the processing of reactor fuel. The wastes from normal operations of reactors themselves can be more easily handled.

A second major problem is to anticipate the accidents that will inevitably occur and to set up safety standards which will insure that they do not become catastrophes.

Considered in this light, it appears feasible to use nuclear reactors in central station power plants and in naval vessels.

Recommendations

In the light of these findings the study committees have made a number of recommendations. Those of the genetics committee apply most directly to all of us. They are:

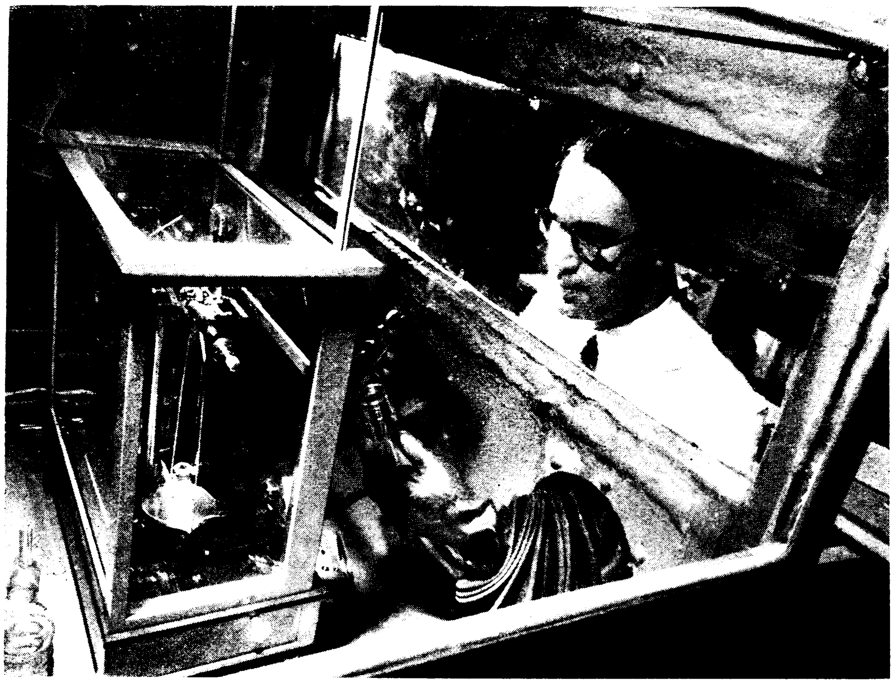
(1) Records should be kept for every individual, showing his total accumulated lifetime exposure to radiation.

(2) The medical use of X-rays should be reduced as much as is consistent with medical necessity.

(3) The average exposure of the population's reproductive cells to radiation above the natural background should be limited to 10 roentgens from conception to age 30.

(4) The 10-roentgen limit should be reconsidered periodically with a view to keeping the reproductive cell exposure at the lowest practicable level.

(5) Individual persons should not receive a total accumulated dose to the reproductive



MAGNETIC MATERIAL — Scientists of the Westinghouse Electric Corporation have perfected a magnetic material, highly purified manganese-bismuth, that promises to yield powerful permanent magnets. Dr. Alex Goldman is shown here weighing a sample, which must be handled in the inert atmosphere of helium in order to avoid the spontaneous combustion that would otherwise occur.

cells of more than 50 roentgens up to age 30 years, and not more than 50 roentgens additional up to age 40. (About half of all U. S. children are born to parents under 30, nine-tenths to parents under 40)

Other recommendations of general interest are:

(6) Techniques for monitoring world-wide fall-out should be further improved.

(7) Measurements of the storage of radiation in the stratosphere should be continued and extended.

(8) A national agency should control and keep records of all dumping of radioactive material in the ocean.

(9) An international body should set up safe standards for the marine and air disposal of radioactive materials as soon as possible, based on current knowledge.

(10) Research in marine disposal should be carried out on a cooperative international basis.

(11) Until advances in reactor technology substantially reduce potential hazards buildings that house reactors located near populated areas should be sealed against the release of radioactive materials in the event of accident.

(12) Research should be continued and accelerated, particularly in the fields of:

Fundamental genetics, mammalian genetics, human and population genetics

Pathological effects of radiation

Mixing between various parts of the atmosphere

Mixing between various parts of the oceans

The role of plants and animals, both on land and in the oceans, in concentrating radioactive materials

The tolerable levels of radioactivity in human and animal food

Geophysical and geochemical aspects of the ultimate disposal of radioactive wastes

Selection of biologically suitable sites for various atomic facilities

Safety devices for the control of accidental power surges in reactors.

The conclusions were announced by Dr. Detlev W. Bronk, Academy president, and the six committee chairmen who are leading more than 100 United States scientists in a continuing study concerning various aspects of radiation problems, both those known at present and those possibly occurring in the future.

Study committees and their chairmen are: genetics, Dr. Warren Weaver, vice-president for the natural and medical sciences of the Rockefeller Foundation; pathology, Dr. Shields Warren, pathologist of the New England Deaconess Hospital, Boston; agriculture and food supplies, Prof. A. Geoffrey Norman, University of Michigan's botany department; oceanography and fisheries, Roger Revelle, director of Scripps Institution of Oceanography, La Jolla, Calif.; meteorology, Harry Wexler, director of meteorological research, U. S. Weather Bureau; and disposal and dispersal of radioactive wastes, Abel Wolman, sanitary engineering professor, Johns Hopkins University.

Science News Letter, June 23, 1956

ZOOLOGY

Plant-Like Animals Need Nitrogen for Sex Life

➤ CONTROLLING NITROGEN supply in certain microscopic plant-like animals can stimulate the "mating urge."

Emil Bernstein and Dr. Theodore Jahn, University of California zoologists, have been conducting such experiments with one-celled organisms known as *Chlamydomonas*. These tiny creatures can move in water like animals and, through plant-like photosynthesis, can create their own food.

The two U.C.L.A. scientists found that the mating urge could be stimulated by increasing light intensity in the organisms' environment, reducing nitrogen in their food source or by allowing them to age.

The organisms began to reproduce sexually following such stimulus. Prior to these conditions they display little or no sexual activity, although the cells may reproduce by simple division.

Nitrogen depletion, common to the three conditions, may be the key to sexual activity. The researchers speculate that changes in nitrogen levels may have something to do with synthesis of a sex hormone-like substance in the organism.

It is possible the nitrogen factor is related to some sexual cycle in these tiny organisms that parallels the sex hormone-controlled cycle in higher organisms including man, the investigators said. This possibility is now being explored.

Science News Letter, June 23, 1956

ASTRONOMY

Will Chart Motions Of 180,000 Stars

➤ SOME 180,000 stars will be photographed during the next few years at Bergedorf and Bonn, Germany, to determine their proper motions, a University of Virginia astronomer has reported.

Dr. A. N. Vyssotsky of Leander McCormick Observatory said the recalculated values for the stellar motions are expected to shed new light on the size of the Milky Way galaxy in which the sun and planets are located.

The study of proper motions will also be extended to stars visible only from the Southern Hemisphere, Dr. Vyssotsky reported at a dedicatory symposium for the University of Pennsylvania's Flower and Cook Observatory near Paoli, Pa.

At the symposium, Dr. Peter van de Kamp, director of Swarthmore College's Sproul Observatory, said astronomical photography had reached such a high degree of accuracy that stars invisible even to a camera can be measured by their effects on the motions of other stars visible photographically.

Dr. F. Bradshaw Wood is the director of the new observatory, which combines the functions of the University's old Flower Observatory and its Cook Observatory.

Science News Letter, June 23, 1956