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CONSUMER reports

A REPRINT PREPARED BY CONSUMERS UNION IN THE PUBLIC INTEREST

A study—the most tho[illegible]
yet undertaken—of the [illegible]out on

THE MILK WE DRINK

Based on laboratory tests [illegible] samples collected from 50 cities throughout the U.S. and Canada

The milk all of us drink—

New public health problems are raised by the effects of radioactive fallout on vital

evaluating the present and potential hazard and including test

EVER since radioactive coral fell as white ash across the decks of the Japanese fishing boat Fortunate Dragon in the spring of 1954, fallout from nuclear bombs has been making both news and history. Its involvment with man and his food supply has entangled it in issues ranging from the biological to the diplomatic. Nor have the public press, official statements, or comment from independent scientific sources unraveled the tangles. What fallout means to us, and what to do about it, still are the most controversial issues of all.

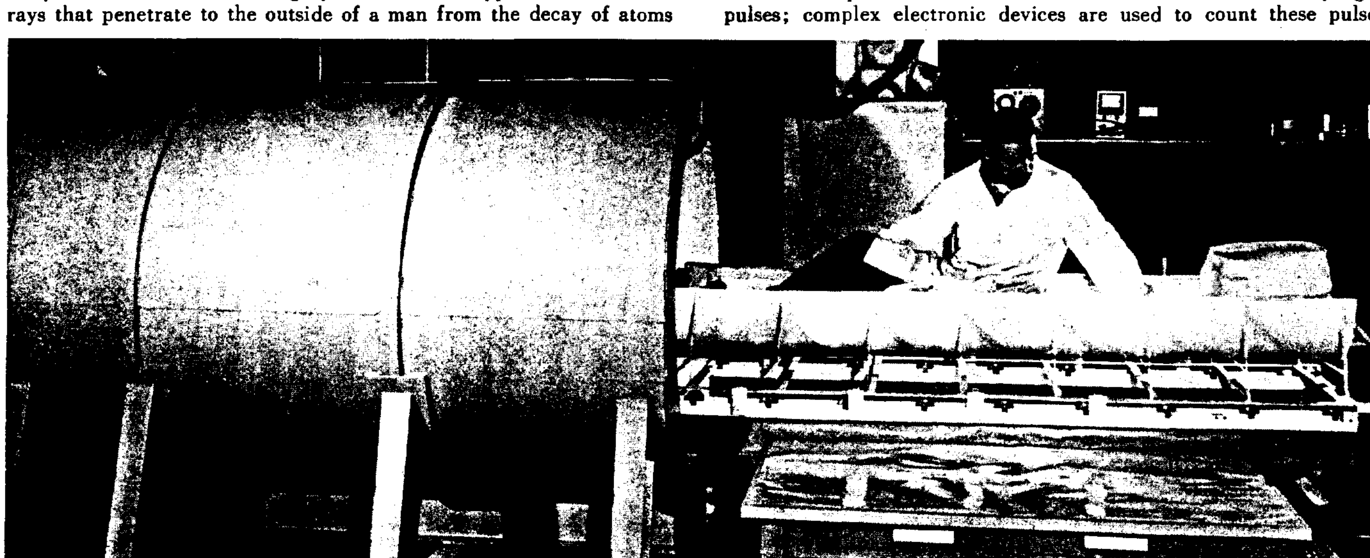
The radioactive materials which fall out of the upper atmosphere after nuclear blasts pass through a number of physical, chemical and biological processes, some of which take years to occur. Each of these steps is a link in a long chain of events which connect the blasts to damage in people, the living and the yet unborn, even thousands of miles away and years later. The scientific facts about some of these links have been well established. Our knowledge of other important links is vague and incomplete. It remains necessary for us to arrive at some assessment of the hazard, even though not all the necessary evidence is in.

Every day each person in the world is exposed to and consumes some measurable debris from fallout in his food, in his drink, in the air he breathes. What this may mean to him in general—but with particular reference to radioactive strontium-90 in the U.S. milk supply—is the substance of this report.

It seems wholly right for a consumer testing organization to undertake to evaluate a new constituent of our food, even one not proclaimed on any label. The main sources of information on the problems of fallout have been the Atomic Energy Commission and, to a much lesser extent, other Government agencies such as the United States Public Health Service and the Food and Drug Administration. Other governments and the United Nations also have published extensive data on fallout; but, as a Congressional Committee reported in 1957, "Information on fallout has evidently not reached the public in adequate or understandable ways."

For at least a decade, the AEC has been studying fallout problems of all kinds—physical, chemical and biological. Measurements have been made of radioactive fallout materials in air, soil, water, people, and foods—including milk, which is the principal source of strontium-90 in the diet of Americans. The responsibility of the Public Health Service for safeguarding the health of the country has led it, too, since 1956, to study fallout materials in air and food, particularly in milk. But these studies have been mainly exploratory, to study methods and to obtain typical values; they have not explored as yet the full gamut of possible

Some of our knowledge of the normal radioactivity of the human body has come from counting cylinders of this type, which measure rays that penetrate to the outside of a man from the decay of atoms within him. The tank, heavily shielded against external radiation, contains a liquid in which the radiation manifests itself as tiny light pulses; complex electronic devices are used to count these pulses



LOS ALAMOS SCIENTIFIC LABORATORY—UNIVERSITY OF CALIFORNIA

and fallout

foods. Herewith a 10-page report, data for the milk supply in 50 cities

sources of radioactive materials in man's diet and in his environment. With respect to milk, the samples examined have not necessarily represented the milk being drunk by the majority of consumers even in the few areas studied.

By testing samples of milk purchased over store counters in 50 widely-distributed places in the U.S. and in Canada, CU has sought to extend the work done by the Government agencies. The results, which are presented on pages 108 to 110, serve to check the relatively scant data on milk published by the AEC and the PHS, and to extend their coverage to include many more areas. That a private organization of limited means can carry out such a program suggests that an expanded monitoring network should be economically feasible under Federal, state, or even community or dairy auspices.

CU goes further. Though the interest of the PHS in the matter has led it to equip and staff some very competent laboratories, it is still true that the overall problem has remained the province of the AEC. But it is hard to see why judgments on matters of public health should have to depend primarily on the reports of the very agency charged with the responsibility of manufacturing nuclear weapons, rather than on those of an agency whose specific job is to safeguard the public health. Without reflecting in any way on the AEC's competence or integrity, CU would support measures which would lead to thorough and independent investigations (as well as routine surveillance) by the Public Health Service on fundamental biological and control problems, wherever there is concern with fallout.

The fact is that fresh clean milk, which looks and tastes just as it always did, nevertheless contains (wherever you get it these days) an unseen contaminant, a toxic substance known to accumulate in human bone. There is an analogy: bacterial contamination. There, too, the presence of unsensed contaminants can bring grave harm. Most of us, even if we are not bacteriologists, know by now the danger from germs, and yet know how to estimate it rationally, and not to fear it unreasoningly. It is exactly with this kind of reasoned concern that we seek to approach the more novel problem of fallout contamination.

■ ***In the next column and on the next few pages, before we proceed to the results of our analyses of milk samples, we propose to tell something of the story of low levels of radiation as they existed in the pre-atomic-bomb era, and of how they have been changing since. For it is only against this background that the findings have meaning.***

THE LIVING AMPLIFIER

Why fallout creates a problem

In the time it takes you to read across this line, many thousands of the individual atoms which make up the matter of your own body spontaneously disintegrate. These disintegrations occur in all human beings, in all living things. Radioactive materials always have been with us in extremely minute quantities. They exist in the foods we eat and consequently in the tissues of our bodies. Some radiant energy produced by the disintegrations, rather like the X rays to which we may be subjected by a dentist or physician, passes right out of the body. If you climb into a "counting cylinder" (see photo), the special liquid inside the tank's wall will react to this radiation and translate it into tiny pulses of light.

Our senses cannot detect such radiation at all—which does not mean that it is without consequence for living matter. Just as the rays by their bombardment produce light pulses within the special liquid of the tank, so they produce changes in the living cells through which they pass. The energy thus imparted within these cells is small in total amount, but it is intensely concentrated; an average of a few hundred atoms will be altered chemically in every living cell through which the rays pass. And thus begins a biological chain of events.

For living matter acts as a kind of amplifying system, somewhat analogous to the electronic circuits of the laboratory counter. The living amplifier takes time; it is slow to respond. Sometimes the cell which was damaged by traversing rays will recover. But the damage to one or a few cells may become in time a self-regenerating and uncontrollable tumor. If the cells affected are cells of the special reproductive tissues, the damage may be done to the subtle molecules of genetic material which contains the blueprint for the next generation; such damage is what we call *genetic*. When the damage is to a cell of the body *not* engaged in reproducing the next generation, the effect is said to be *somatic*. In its most serious form the somatic damage may be malignant (cancer or leukemia); in milder form, it may appear as an apparent acceleration of the aging process. For very low levels of radiation, it may be that no somatic effect is observable.

The "counting cylinder" in the photograph across the page includes in its count the rays from a perfectly normal constituent of all living cells: potassium. This chemical element is essential to life, as every gardener knows; one of its isotopes (isotopes are chemically identical but physically different atoms) is radioactive. In a normal 160-pound man, about 5000 atoms of this isotope (potassium-40) decay each second throughout life. Radiation passes through us not only from internal sources like the potassium in our muscle tissue, but from external sources as well. The very rocks around us contain uranium and thorium in small amounts, along with their radioactive relatives, particularly radium. And there are the cosmic rays, which come in from interstellar space to strike us.

In short, we know that life always has grown in the midst of penetrating radiation. The question must be put: *How much has that radiation been?* We have to work out some answer to that question before we can proceed to the next one: *How much more, if any, can we tolerate?*

The "permissible" radiation burden

The adjective doesn't mean what many people think, and no one knows precisely what it does mean; but here's how it's worked out

THERE are many ways of measuring radiation. The measure which we shall use is a measure of the energy absorbed from radiation in a given amount of tissue: the unit is called the rad (100 ergs absorbed per gram of tissue).* This is not much energy; in terms of heat, 500 rads would serve to raise the temperature of the tissue only 1/500 of a degree Fahrenheit—imperceptible. But that same 500 rads delivered to a human being by penetrating radiation, in a kind of three-dimensional sunburn, is deadly; a man who receives that much over the whole body within a short time has just about an even chance of surviving a month. The normal external dose is, of course, very much less.

It is interesting to tabulate some external doses of radiation received by people in a lifetime (about 70 years) under ordinary conditions. The dose varies from place to place. The high mountains have a thin layer of air above them, and the cosmic rays from space, accordingly, are in abundance there. Some places have sub-soil rather free from radioactive elements, and the earth's contribution is small there. Here is a small table of typical results (taken from an AEC source):

EXTERNAL RADIATION DOSES

Place	rads per 70 years
TOLEDO, OHIO	5.3
PITTSBURGH, PA.	6.7
LITTLE ROCK, ARK.	7.4
COLORADO SPRINGS, COLO.	12
AVERAGE OVER U.S.A.	about 7 (out-of-doors)

Other common sources of external radiation are: from TV tubes and luminous watch dials, less than 1/5 rad per 70 years; from diagnostic X rays (in the U.S., at least—see CONSUMER REPORTS, September 1958), an amount generally not exceeding 10 rads per 70 years.

In Kerala, at the southern tip of India, about 100,000 people live in fishing villages strung out along a hundred miles of a geological curiosity, an ocean beach whose black sands are radioactive; the people who live there have always lived in a radiation field about ten times the U.S. average. If adequate medical diagnosis and vital statistics existed for these people, their very long exposure might furnish extensive information on the long-term effects of greater-than-average radiation on human beings. Unfortunately, we have no such statistics for them or for any other highly-exposed population, and no way of quickly acquiring such data. Nevertheless, as radiation gradually increases from man's activities in the atomic age, obviously must attempt to make such estimates as we to find out where the risk gets serious, where intoler

THE TOLERANCE DOSE

The view that there exists some degree of exposure b which there is no appreciable harm often is expresse terms of a "threshold" dose. Cross the threshold, and ger begins; stay below, and the processes of recovery repair reduce to negligible proportions the chance of ble amplification of cell damage. It is claimed that s thing like a threshold, in fact, has been observed in mal and even human exposures, although not at the long-continued doses in which we are now intereste

It is fairly well agreed, however, that genetic da which in humans leads to embryonic deaths, still-b and congenital defects, has no threshold. *Every* in in the dose which affects the genes of some person is to appear statistically in his progeny. Most of this da is believed to be delayed in expressing itself; some r generation may be the first to suffer from it. Such g damage raises quite new problems of medicine, to say ing of morals. And the fact that the extent of such d to humans is not known with precision tends to discussions of the problem.

In the words of the authoritative International Co sion on Radiological Protection (ICRP): "Since no tion level higher than the natural background can garded as absolutely 'safe,' the problem is to ch practical level that, in the light of present knowled volves a negligible risk." The practice has been to ac late information bearing on this problem by sur considerable numbers of individuals who work with r or X rays, or in the atomic energy industry. On th of such information, "permissible" levels (or "tole doses) for exposure to external radiation have established.

But the history of this concept is not reassurin cause today's "permissible level" is not yesterday level for such workers has been modified steadily, as below:

1928-1936	100 rads per year
1936-1947	35 rads per year
1948-1957	15 rads per year
1957-	5 rads per year

The last figure corresponds (for a 50-year working some 40 times the natural U.S. background radia about seven rads in the course of a lifetime.

*A rad is roughly equivalent to a roentgen, which is an older, common unit for doses of X and gamma rays.

Radiation workers, however, are never under ten years old, nor often over seventy. By their relatively small numbers, they do not represent a fair sample of the diversity of mankind. Just as there are some people who have been found unusually sensitive to sunlight, so there must be some who are more sensitive than others to radioactivity. For such reasons it has been considered desirable to set the tolerance dose for the entire population lower than that for medically-controlled radiation workers. Typically, the maximum "permissible" dose for occupationally exposed people is reduced by a somewhat arbitrary factor of 10 to obtain the maximum "permissible" exposure for people at large.

By such a standard, the general population ought not to receive more than about 30 rads per lifetime, or roughly four times the U.S. background radiation. This does not mean that such a dose is guaranteed to be safe, or that it will produce no damage. On the contrary, it implies accepting as socially tolerable some genetic damage, which can be estimated only very roughly because of our poor knowledge of human genetics.

Estimates, nonetheless, have been made. The U.N. Scientific Committee on the Effects of Atomic Radiation, for example, has attributed to one rad, from any source and applied only once to a single generation of the world's entire population, the capability of causing ultimately 100 to 4000 defective births for each million of the population. The percentages are small (between 0.01 per cent and 0.4 per cent) and the range is large (a tacit admission to the inexactitude of our knowledge). But when applied to the world's population of about 2½ billion people, half of whom are assumed to be below the mean reproductive age, the total number of defective births will range from 125,000 to 5 million,* spread out over scores or even hundreds of generations. These defectives may not be discernible from among the much larger number of cases which are a result of other unknown factors.

Assessments can also be made for the somatic damage induced by radiation. While there is common acceptance of the inevitability of genetic damage, however, there is no such agreement regarding somatic damage. Many scientists believe that a radiation threshold exists for somatic effects, that we have not yet exceeded this value, and therefore that no somatic damage (cancer, leukemia, shortening of the life span) can be attributed to the low levels of radiation to which we have been exposed so far. Other scientists hold to the view that biophysical distinctions cannot be made between somatic and genetic effects and that radiation which causes damage to reproductive cells can also damage any other living cells. No one knows at this time which view is correct.

INTERNAL RADIATION

In addition to the radiation received by the body from without, at least three substances contribute their radiation from within the body, and have done so since there first were men: potassium-40, carbon-14, and radium and its radioactive decay products.

*A conservative estimate, based on the assumption that the world population will not increase.

PHOTO FROM "MEDICINE" MAGAZINE

"Hot spots" in thigh bone of a woman who worked with radium some 30 years earlier show up dramatically in photograph taken by means of intense radiations emanating from the bone itself

Carbon and potassium are necessary components of life: they are fairly uniformly distributed within the body and from person to person, so it seems not unrealistic to be guided by the tolerance dose information developed in our studies of external radiation. It is plain that potassium-40 (which contributes about 1.5 rad per 70 years) and carbon-14 (about 0.1 rad per 70 years) have not added much to the natural background radiation.

But radium is another story. It plays no known role in the life process; it is present because it is widely distributed in the soil and rocks. It is ingested, or sometimes taken into the lungs, and though it is present in very small amounts, its activity can be more important than that of potassium-40 or carbon-14.

Radium is not uniformly spread through the body. Because its chemical behavior closely resembles that of the element calcium, constituent of all bone, radium concentrates in the bones. Furthermore, in large doses it does not distribute itself uniformly even within the bones. The bone grows most, of course, in youth. But even the mature bone undergoes remodeling; its constituents are steadily being taken up and laid down again. This means that where radium lodges depends on just what part of the bone is active when the radium enters, and on the whole complex matter of bone formation, growth, and maintenance.

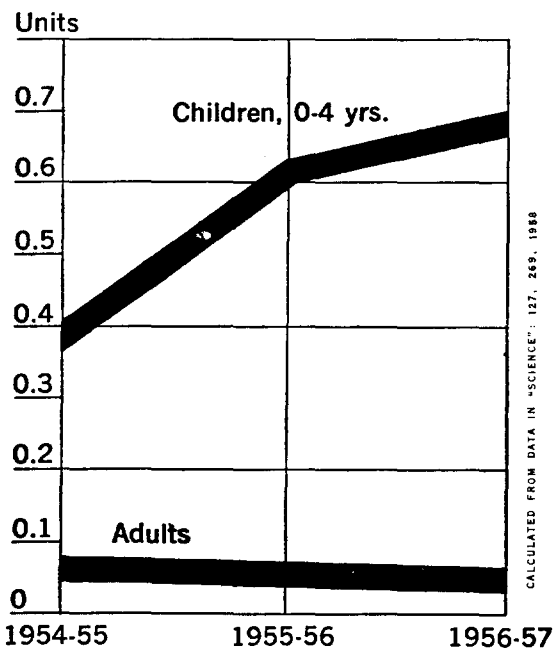
The energy emitted in the decay of radium is chiefly carried by particles which cannot penetrate the whole body to reach the outside. They spend all their energy in a distance of a thousandth of an inch; they deposit a thousand times as much energy in crossing a cell as do the rays from potassium-40. The variability of the site of radium also implies its possible concentration in local "hot spots" beyond the average value (see photo above).

A hundred or so persons have been examined who have held excessive amounts of radium in their bones for decades. Some of these were young women who painted the small numerals on luminous dials, and tipped the brushes between their lips for the fine work. Some were suffering from rheumatism or other diseases, and were given radium as a therapy by some sincere physicians and by more quacks, in the 1920s before the grave danger was recognized. In all of these groups, there have been seen malignancies of bone and of blood—evident consequences of the radium irritation.

What is striking is that the incidence of these conditions, rare in the total population, was large enough in the small number of radium-poisoned patients to be recognized without chance of error. There is a good chance of developing a bone tumor, or leukemia, if you fix in the bones a mere speck of radium; less than one microgram, an amount 1/30,000,000 of an ounce, weighing less than the dot over an inked i. It seems very probable that, if there is a safe threshold at all here, it is below a tenth of a microgram, an amount which is a few hundred or a thousand times greater than that found in the normal skeleton. The present ICRP recommendations allow a tenth of a microgram of the stuff for workers in radiation industries, and such an allowance does not preclude the possibility of undetected subclinical changes. If we recall that there may be no threshold for somatic effects, but a straight-line relationship, and that individual responses are variable, it is reasonable to include at least a factor of 10 for safety in setting the "permissible" internal bone burden for the population at large. The UN places the normal average radium dose to the bone at a value of about 3 rads over 70 years. Somewhere in the range from ten to a hundred times the background value the "permissible" value lies.

Now there enters a new factor: the element strontium.

AVERAGE STRONTIUM-90 IN BONES



Notable amounts of strontium are absorbed only by growing bones. Averages above were calculated on the basis of data compiled from four U.S. cities

Strontium–90:

THE element strontium is relatively uncommon; its most common use is for the rich red of its flame in fireworks and flares. Like radium, it also resembles calcium and it also becomes stored in bone.

The normal skeleton of man has about two pounds of calcium, and with it from soil and rock there has always been deposited about a tenth of a teaspoonful of strontium. Normal (pre-atomic-bomb age) strontium presents no hazard, so far as anyone knows; it is not radioactive.

But every explosion of a nuclear bomb spreads into the high air with its fireball a new radioactive isotope of strontium, strontium-90. It comes from fission, and the old-style fission bomb and the new-style fission-fusion-fission bomb both contribute strontium-90. (The yet undeveloped "clean" bomb will contribute proportionately less as it makes less use of fission energy; no one has yet discovered how to eliminate the stuff entirely.)

So far some 200 pounds of strontium-90 have been carried aloft by the churning hot gases of the mushroom explosions. It has spread worldwide. It falls out of the upper atmosphere, in a manner not yet fully understood. It comes down slowly with rain and snow, on river and reservoir, plant leaf, and soil. Some of it is taken up chemically through the roots of plants to become part of grass or seed, and eventually part of the glass of milk or the rice in the bowl. In the U.S., about 80 per cent of the minute quantity which enters our bodies comes to us in our milk. In Japan more than two-thirds comes from rice. Unpolished or whole-wheat, unfiltered rain water, and similar items of diet, such as vegetables, may also contribute a significant amount of strontium-90. If there never are any more explosions, the fallout *from tests already made* will reach a maximum about 1970, rising to two and a half or three times its present value, and then will decline slowly for a generation or two.

There is not much of it. The load of strontium-90 in your front yard is likely to be about one-tenth of a microgram. It is spread down into the topsoil by rain and plant growth and hoe and worm; how much is taken up by plants depends on a wide variety of conditions—upon the depths of their roots, the chemistry of the soil, the distribution of rainfall, and so forth. But it is out there, and it enters the food chain and, from there, the bone.

Among all the scores of constituents of fallout, strontium-90 is especially hazardous because it is released in considerable quantity (it forms a few per cent of all radioactive products of fission), it seeks the bone, and it stays there a long time. Some of the other radioactive products decay so quickly that they cannot pass through the long chain of events to reach the target; some which have a long life do not accumulate in the body; but strontium-90 lasts on the average about 40 years and it accumulates in bones.

What will strontium-90 do in bone? Both general theory and direct animal experiments (with rather heavy

a special hazard

doses) suggest that the longer-ranging rays of strontium-90 (and its radioactive decay product yttrium-90) are in fact only one-fifth or one-tenth as damaging as radium rays, energy for energy. On the other hand, the concentration of strontium-90 may show "hot spots," in the same way as does radium. And localized damage will tend to reflect not the average but the maximum insult done to living cells. Prudence dictates that we increase our estimate of damage by a factor of five or ten to take into account the possible effect of the concentrating tendency; that is the practice of both the ICRP and the UN.

It appears that 1 S.U.* contributes about 1/5 of a rad in a seventy-year residence in bone. Various experiments suggest that children whose bones are being formed from current milk supplies are retaining strontium-90 at a level between ½ and ¼ of the S.U.'s in their milk. On the basis of these facts we can set a rough maximum "permissible" burden of strontium-90. If we follow the argument already made for radium, which seems the one closest to the real situation, we could allow a burden of nearly 150 S.U. before reaching the 30 rads which we set as a rough "permissible" burden for the bones of an average individual. The use of somewhat arbitrarily-selected factors at several stages in such calculations may be viewed as suggesting that a maximum "permissible" dose *might* lie somewhere in the large range from as little as a fifth of the 150 S.U. to as much as ten times that.

It does not seem safe, however, to apply to the poorly known and highly variable bone burden, affecting the whole world's people, any smaller safety factor than that used for external radiation. In this case one would again set the limit at something near 30 rads, several times the natural internal burden. This gives us our 150 S.U. again, which agrees well enough with the ICRP limit of 1955, put at 100 S.U.

But it must be emphasized that any "permissible" level obviously is predicated on the assumption that there is a threshold dose for strontium-90 below which any effects are insignificant. The absence of a threshold would mean that bone damage would be proportional to the dosage in any amount, and the concept of a tolerance dose would then imply accepting as socially tolerable an unknown number of radiation-diseased individuals.

The summary table on this page presents average ranges for radiation dosages, based on authoritative estimates. It should be emphasized that these figures are approximate. Even if the population has an average dose rate within the "permissible" limit, there are many individuals, of course, who are receiving much more.

*Abbreviation for Strontium Unit. Expresses the number of micro-microcuries of strontium-90 per gram of calcium.

RADIATION DOSAGES Summary table

EXTERNAL	rads/lifetime (USA) (approximate)
Maximum "permissible" dosage for the population at large	30
Natural: cosmic rays, soil, rock	4 to 10
Man-made, at present: diagnostic X rays	5 to 10
fallout	up to ½
other sources, including TV tubes	up to ½
Approximate total	10 to 20
Balance to reach "permissible" level	20 to 10
INTERNAL	
Natural: carbon-14, potassium-40, radium	2 to 6
Man-made strontium-90 (bone dose):	
Maximum "permissible" dosage calculated from the ICRP recommendation of 100 S.U.	up to 20*
Assuming cessation of bomb tests—	
For young children, 5 to 10 years hence	½ to 1*
For adults (bones mostly formed in pre-atomic bomb era)	up to 1/10
Assuming continuation of tests at past rate—	
For young children, 50 to 60 years hence	5*

*Not taking into account natural decay or deceleration of bone growth with age

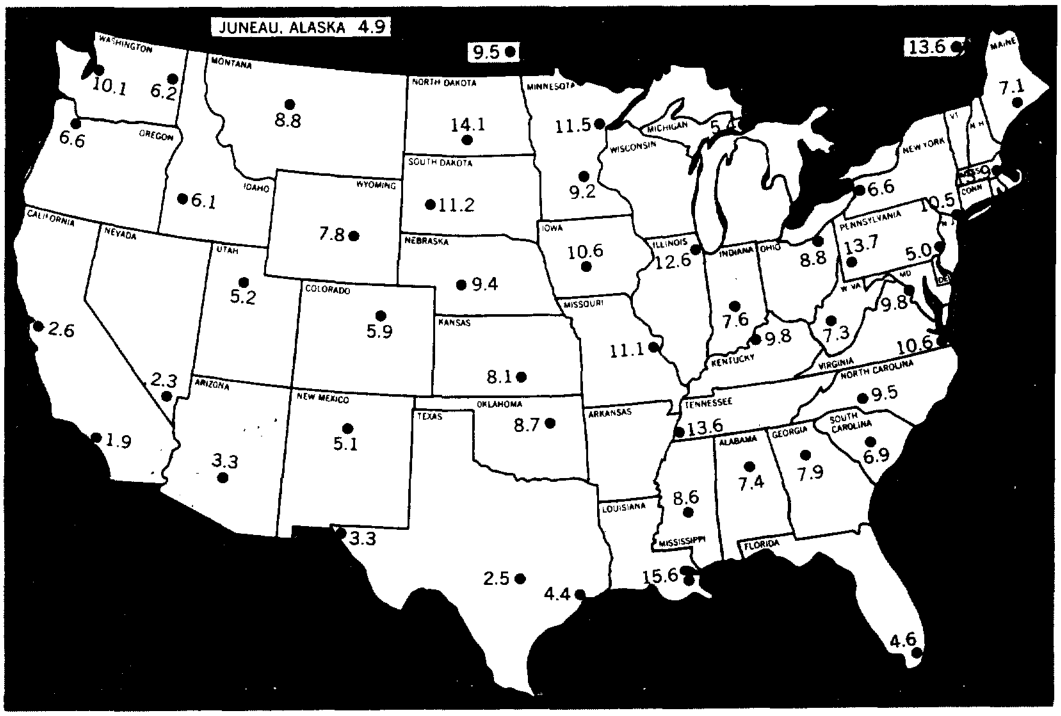
OTHER FALLOUT PRODUCTS

The isotope carbon-14 is a normal component of the air and of our food; it contributes a little to the normal internal burden, rather uniformly over the body. But it also is made in appreciable quantity by all nuclear weapons, fission or fusion, dirty or clean. These already have contributed a good deal of the stuff to the air, enough to raise the amount present in living things by about one-third of 1 per cent. This isotope is very long-lived, averaging about 8000 years. In the present generation, the effects of carbon-14 will be small, compared to the genetic and possible leukemia-inducing effects of the other components of fallout. But since it lasts such a long time, it can be shown that its cumulative genetic effect is some 10 or 20 times greater than that of the other fallout components, stretched out as congenital defects of posterity.

Another isotope, cesium-137, is copious in fallout. It can be detected from within the living body because, like potassium, it emits penetrating radiation. It bears much the same relation to the essential potassium that strontium bears to calcium. But it is a rather short-time resident of the body, staying there a matter of months, rather than the decades typical for strontium. The overall effect of cesium is to increase the dose received from radiations like that of potassium by about 15 per cent.

The possibility of damage by other fission-produced isotopes (such as plutonium-239) not yet studied extensively should not be forgotten; the whole fallout problem raises new tasks for those who control the wholesomeness of modern foods, water, and air.

For results of CU's study, see the following pages



The milk samples for CU's tests were bought in these 50 localities. The figures represent the number of strontium units found in the samples from each locality last summer. A full list is given in chart form on the facing page, along with comparable figures from other surveys

CU's study—data and meaning

FOR reasons advanced on the preceding pages, strontium-90 assumes a degree of importance far out of proportion to the seemingly small absolute amounts involved. It is, in fact, generally agreed that strontium-90 presently constitutes one of the most serious potential hazards attributable to fallout, and that milk is the primary route by which it enters the bodies of most Americans.

The U.S. Public Health Service has been analyzing milk (for strontium-90 and other radioactive isotopes) once each month since 1957 in five geographic areas; this program was enlarged in 1958 to include 10 areas. Sample collections for analyses are made on a single day of each month from each area and represent a single group of farms from the same production area. Because these samples do not include milk from other farms which contribute a substantial part of the milk supply to consumers in most of the areas covered, the samples do not necessarily represent the actual milk supply of a given population center.

The Atomic Energy Commission has reported on milk in several U.S. cities, but it has covered only four of them with any degree of thoroughness. Except for New York City, samples examined by the AEC usually have been powdered milks, which may not be typical of milks found in the consumer market (a fact observed, in at least one instance, by the AEC itself).

There have been other more limited studies of the strontium-90 content of milk. The University of Chicago, for example, has been closely monitoring the Chicago area, and Columbia University's Lamont Geological Observatory has published data on powdered milks from selected areas of the country. The New York State Department of Health has monitored the strontium-90 content of powdered milk from nine locations within the state.

CU'S PROGRAM

All of these studies have left largely undetermined and unknown the strontium-90 content of the milk supply for most segments of the population. CU's study, reported herein, is the first to attack this problem on so large a scale from the point of view of the consumer. Broad coverage of consumer milk supplies on a more comprehensive national geographic basis than has heretofore been made was the prime objective of CU's project. It was undertaken also to provide an independent, non-government-sponsored check of data released through official agencies, and to point out areas having milk with relatively high strontium-90 content which may merit further study by official agencies.

SAMPLING

CU's milk samples were gathered from 48 cities scattered across the United States and from two in Canada close to the U.S. border. Several considerations went into the selection of these sites. Foremost of these was the requiremen for a good extensive sampling network, with emphasis, wherever feasible, on the larger centers of population. Various distinctive soil regions of the U.S.—as classified by the Department of Agriculture—were also included, since soil conditions may be considered as the integrated end-products of climatic, topographical, and geologic effects—all of which are important in affecting the strontium-90 content of soil, which in turn affects the strontium-90 content of pasture, cow, milk, and man.

All areas whose soils had been found by AEC studies to be high in strontium-90 also were included, as well as several sites whose milk had been tested previously by the PHS and the AEC.

At each of the cities selected, CU shoppers purchased eight quarts of fluid milk each week, for a period of four weeks. Generally, two separate across-the-counter purchases were made each week of one quart from each of four major local dairies. Four-ounce portions from each of the 32 quarts thus purchased were composited to provide a total of one gallon of milk for testing from each sampling site. The pooled composites thus obtained represented a major part of the milk supply of each of the cities sampled for the period from mid-July to mid-August, 1958. A total of approximately 1600 quarts were purchased for these tests.

Analyses for strontium-90 were made for CU by a consulting laboratory which specializes in such work, and whose reliability had been established by check-sample data provided by the AEC as well by CU.

In drawing up its program for sampling and testing milk, CU consulted the Lamont Geological Observatory, the Atomic Energy Commission, the U.S. Department of Agriculture, and the U.S. Public Health Service, and gratefully acknowledges the suggestions made by these organizations.

RESULTS

The data obtained by CU, together with some related results from other laboratories, are shown in the Table on this page. CU's data, it should be emphasized, provide breadth rather than depth of coverage. Any trend or variation of strontium-90 content with time or other factors cannot, of course, be noted by a one-period sampling and analysis. The best data available for observing the progressive change in milk's strontium-90 content probably are the monthly figures of the PHS.

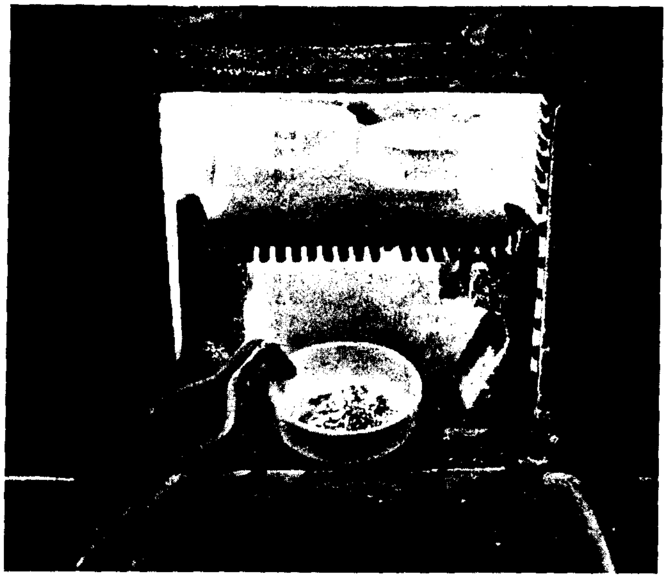
From these and other studies, there is incontrovertible evidence that the strontium-90 content of milk has been increasing since 1954. The average rate of increase was estimated by the AEC in 1957 to be between 0.5 to 1.0 S.U. per year for past years. The overall average of 48 U.S. cities sampled by CU is 8.0 S.U.; the average of the 10 cities covered by the PHS for approximately the same period is 7.6 S.U., a figure that is in good agreement with that found by CU considering the differences in the sites sampled and in the nature of the samples. For purposes of noting change, an overall estimate of the strontium-90 content of milk in 1957 may be obtained by averaging figures published by the PHS for five cities sampled that year (4.35 S.U.) or by taking the average which was published by Lamont (6.1 S.U.). It would appear from these figures that the strontium-90 content of milk in mid-1958 was more than two

CONCENTRATIONS OF STRONTIUM-90 IN MILK

CITIES WHERE SAMPLES WERE TAKEN		CONSUMERS UNION July-August 1958 S.U.	PUBLIC HEALTH SERVICE July-August 1958 S.U.*	ATOMIC ENERGY COMMISSION S.U.	ATOMIC ENERGY COMMISSION Sampling period
ALABAMA	Birmingham	7.4			
ALASKA	Juneau	4.9			
ARIZONA	Phoenix	3.3			
CALIFORNIA	Los Angeles	1.9			
	Sacramento		4.6		
	San Francisco	2.6			
COLORADO	Denver	5.9			
D. C.	Washington	9.8			
FLORIDA	Miami	4.6			
GEORGIA	Atlanta	7.9	9.4		
IDAHO	Boise	6.1			
ILLINOIS	Chicago	12.6	7.6		
INDIANA	Indianapolis	7.6			
IOWA	Des Moines	10.6			
KANSAS	Wichita	8.1			
KENTUCKY	Louisville	9.8			
LOUISIANA	New Orleans	15.6			
MAINE	Bangor	7.1			
MASSACHUSETTS	Boston	13.9			
MICHIGAN	Sault Ste. Marie	5.4			
MINNESOTA	Duluth	11.5			
	Minneapolis	9.2			
MISSISSIPPI	Jackson	8.6			
	State College			4-6	May-Sept./56
MISSOURI	St. Louis	11.1	13.4		
MONTANA	Great Falls	8.8			
NEBRASKA	North Platte	9.4			
NEVADA	Las Vegas	2.3			
NEW MEXICO	Sante Fe	5.1			
NEW YORK	Buffalo	6.6			
	Perry			3	Jan.-Mar./58
	N. Y. C.	10.5	6.5	4	Jan.-Mar./58
NORTH CAROLINA	Charlotte	9.5			
NORTH DAKOTA	Bismarck	14.1			
	Fargo		11.9	20-30	Oct.-Dec./57
	Mandan			15	Jan.-Mar./58
OHIO	Cincinnati		9.4		
	Cleveland	8.8			
OKLAHOMA	Tulsa	8.7			
OREGON	Portland	6.6		5-6	Apr.-June/56
PENNSYLVIANA	Philadelphia	5.0			
	Pittsburgh	13.7			
SOUTH CAROLINA	Columbia	6.9			
SOUTH DAKOTA	Rapid City	11.2			
TENNESSEE	Memphis	13.6			
TEXAS	Austin	2.5	3.0		
	El Paso	3.3			
	Houston	4.4			
UTAH	Salt Lake City	5.2	4.1		
VIRGINIA	Norfolk	10.6			
WASHINGTON	Seattle	10.1			
	Spokane	6.2	5.9 (Aug. only)		
WEST VIRGINIA	Charleston	7.3			
WISCONSIN	Columbus			4	Jan.-Mar./58
WYOMING	Casper	7.8			
CANADA	Quebec	13.6			
	Winnipeg	9.5			

**Figures were obtained by averaging the July and August single-day samples, and have been converted from the micromicrocuries of strontium* per liter *in which the PHS data originally appeared.*

To measure the concentration of strontium-90 in test samples of milk, CU's consulting laboratory boiled the water away and then burned off the organic matter in an electric furnace (below). The resulting ash was then dissolved, and the calcium and strontium precipitated and filtered (right). By measuring radiation in the residue, technicians could calculate the strontium-90 content



S.U. greater than it was in 1957, which is at least double the AEC estimate for the annual rate of increase over the last few years. This more rapid rate of increase must be considered tentative, since data for all of 1958 are not yet available. The summer months, when cows graze on the open range, are more likely to yield milk with a higher strontium-90 content than winter months, when cows are fed on stored hay and fodder. Offsetting to some degree such an anticipated drop in the strontium-90 content of milk for the latter half of 1958 will be the effects of fallout from the stepped-up rate of weapons testing during the period August to November 1958. Because of this testing, it may be assumed reasonably that the average strontium-90 content of milk as currently consumed in the U.S. is about 8 to 10 S.U., and will likely be closer to the higher figure during the coming summer.

However, an average may be falsely reassuring. Local meteorological conditions and other factors conceivably could create conditions resulting in high concentrations in relatively small areas that embrace large numbers of people. In CU's tests, a range from about 2 S.U. to almost 16 S.U. was found in the composited samples. It has been estimated that a factor of five applied to the average found would encompass most of the variations that might be expected for all factors. In such "hot" areas the concentration of strontium-90 in milk might be about 50 S.U. —more than half the currently recommended maximum "permissible" concentration.

In its tests of samples collected in July and August 1958, CU found that the strontium-90 in the milk supplies of several cities was about twice the average of the others. These seven cities were:

NEW ORLEANS, LA.	15.6 S.U.
BISMARCK, N. D.	14.1
BOSTON, MASS.	13.9
PITTSBURGH, PA.	13.7
MEMPHIS, TENN.	13.6
QUEBEC, CANADA	13.6
CHICAGO, ILL.	12.6

Several other cities were well above-average, though not so much as those above:

DULUTH, MINN.	11.5 S.U.
RAPID CITY, S. D.	11.2
ST. LOUIS, MO.	11.1
NORFOLK, VA.	10.6
DES MOINES, IOWA	10.6
NEW YORK CITY	10.5
SEATTLE, WASH.	10.1

As was to be expected, most of these cities are in the northern part of the country; several high-count areas were found in the southern part of the U.S., too. Ten of the 13 U.S. cities just listed are not included in the present PHS test network. It appears to CU that the PHS would do well to extend its testing to include at least these 10. Furthermore, it appears to be desirable to investigate the milk supplies of all other areas which have not been included up to now in any study, in order to locate any other areas whose milk is abnormally high in strontium-90. It is further suggested that the study of milk supplies might profitably include provision for more representative sampling than has been the practice in the past.

What's to be done?

THIS report cannot be ended with a clear recommendation. None exists. No doubt the Best Buy is milk without strontium-90, air without fallout, and adequate medical care without diagnostic X rays. But none of these solutions are to be had, and it would be as foolish to stop drinking milk as it would be to refuse an X-ray examination for a broken limb. The surveys of the strontium-90 content in milk made by CU and by other agencies have demonstrated that there *is* a potential hazard. A judgment as to whether we are now within or without prudent limits depends on a variety of uncertain factors—ranging in character from the nature of bone growth to the problem of leukemia induction by X rays—the answers to which have not yet been set by science. Even if those answers were in, we are far from knowing how variable can be the responses of man and weather and soil the world around.

Here is a new problem in public health: a world-wide hazard which neither man nor nature can wash away.

We can surmise that we still are not heavily dosed, but we also can be sure that there have been unattributed individual tragedies caused to persons by fallout. Further, we can project the data here presented in weighing the consequences of a major war fought with nuclear weapons. It is probable that in such a war the surviving belligerents would find themselves confronting many thousands of times the average fallout hazard which tests to date have produced. and neutral lands across the globe could expect hazards a thousand times greater than what they have now.

What's to be done? Much research is now being carried on, but investigation of all the unknown factors is urgently needed. Among other areas, practical measures to reduce the absorption of strontium-90 from soil and to eliminate it from milk are being studied. Of course, such measures may be only palliatives. It is the diplomat who holds the key to the solution of the base problem: cessation of nuclear explosions in the atmosphere (see below).

The growing use of fission-operated power plants requires a similar study because the very fission reactors which will become increasingly important sources of electric power in the years ahead also produce a great deal of radioactivity. Obviously, while the bomb would spread the radioactivity into the four winds, the fission plant may be able to keep it carefully sealed up and safely disposed of. But managing the safe storage of the long-lived radioactive by-products is by no means a simple problem. Here, too, the initiative of the Public Health Service (supported by Federal legislation for control of radiation), and eventually of the World Health Organization, would be logical.

With this report CU hopes to stimulate wider interest and understanding on the part of the public, of public health agencies, and of commercial producers in the problems of radiation and in the control of its hazards.

Conclusion based on uncertainty

INTERNATIONAL activity in the fallout problem has produced four major developments since last summer including two significant reports made public by two international groups—one governmental, the other private.

The United Nations Scientific Committee on the Effects of Atomic Radiation issued an exhaustive evaluation of the known scientific facts. The importance of this report lay in its demonstration that scientists around the globe are in substantial agreement on existing and potential hazards.

The second of these reports was issued by the so-called Pugwash group sponsored by Ohio industrialist Cyrus Eaton and named for its original meeting place—Mr. Eaton's summer retreat at Pugwash, Nova Scotia. The 1958 "Pugwash" meeting was the third in a series begun in response to an appeal for an international forum of scientists made in 1955 by Lord Russell, Albert Einstein, and other prominent scientists. The 1958 sessions were held in Austria under the good offices of many sponsors, including the Austrian government. The attendance included not only scientists who have been critical of bomb testing but ones long associated with the scientific policy-making of their countries—such men as Sir George Thomson of England, Prof. D. V. Skobeltzyn of the U.S.S.R., and Prof. Eugene Wigner of Princeton University. The 1958 "Pugwash" statement included a paragraph which rather fairly summarizes the present prevailing opinion among scientists:

"*. . . the bomb tests produce a definite hazard and will claim a significant number of victims in present and following generations. Though . . . the genetic damage appears to be relatively small compared with that produced by natural causes, the incidence of leukemia and bone cancer . . . may . . . add significantly to the natural incidence of these diseases. This conclusion depends upon the assumption (not shared by all authorities in the field) that these effects can be produced by even the smallest amount of radiation. This uncertainty calls for extensive study and . . . for a prudent acceptance of the most pessimistic assumption.*"

Meanwhile, the political pressures generated by public concern at least have been moving diplomatic machinery. A meeting of experts from the big powers in Geneva produced agreement last summer on the feasibility of a control and detection system which could enforce a possible agreement to end tests of nuclear weapons.

And at the time of this writing, diplomats are in Geneva trying, through a welter of bargaining points, to bring about an agreed cessation and a suitable control system. They have wrangled endlessly, and yet there has been about the proceedings an air of hope. The end of tests would, of course, stop the production of bomb fallout in peacetime. Far more importantly, one could view the end of tests, if it came, as a first step toward the prevention of nuclear war.

The report on **The Milk We Drink** was published in **CONSUMER REPORTS** for March 1959, as part of this Table of Contents.

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