given off per unit time and weight is small The radionuclides with short half-lives, on the other hand, will give off large amounts of radiation per unit time If the half-life of one radionuclide is known to be thousands of years and that of another to be tenths of a second, for the same "freshness" and same starting weight of materials, the former will give off a small amount of radiation and the latter a tremendous amount in the same time interval

The kinds of radiation emitted and their energy and relative abundance are constant for each particular radionuclide Such properties of many radionuclides are yet to be established precisely but those of many are well known and published (See Seaborg's "Table of Isotopes" listed under "References ")

As a general rule, if a known radionuclide is present, the kind of radiation, the energy of the radiation, the decay chains or daughter products, and the time necessary to reach a certain level of radiation can be predicted Conversely, if an unknown radionuclide is present, sufficient measurements will lead to precise identification of the radionuclide

A known radionuclide of the element iron is chemically the same as its nonradioactive counterpart, stable iron, so some of it can be mixed with the nonradioactive iron and followed in a process (or a corrosion test) to determine what is happening to it

Persons working with certain radioactive materials can easily detect the presence of the radioactive materials in minute amounts In the case of a radionuclide which has a very short half-life and which is disintegrating rapidly, the *weight* of the material may be very minute but the number of particles being emitted per unit time from the material may be very great

The statement that the acceptable breathing levels of some materials are literally in terms of disintegrating *atoms per day* implies that these materials are extremely toxic They are, but as a general rule they are still measurable and quickly detectable Many toxic (but not radioactive) materials are used routinely in industry, and it may take hours or days to evaluate the extent of the risk Radionuclides, in contrast, usually can be readily detected with appropriate instruments

Guide level concentrations may be found in Handbook 69 published by the National Bureau of Standards

Units of radiation measurement

Radiation may be expressed in several different units The International Commission of Radiological Units and Measurements (ICRU) issued a report in 1962 defining units and measurements (See U S Department of Commerce, National Bureau of Standards, Washington, D C *Radiation Quantities and Units* Handbook 84 Nov 1962 See also National Safety Council Industrial Data Sheets Nos 461 and 475, *Beta Ray Sealed Sources* and *X-Rays in Industry*)

Some of these units follow

Activity is used for the nuclear transformation rate and the "curie" (c) was made its unit The curie is defined as 37,000,000,000 nuclear disintegrations per second It is a *unit of activity, not a unit of quantity* of a nuclide Formerly, it was customary to say "Y curies of phosphorous-32 were used " It is still permissible to say this, but it is preferred to use the longer form which is now correct "A quantity of P-32 was used whose activity was Y curies "

Exposure" is a measure of the ability of X and gamma rays to produce ionization in air The exposure is "the quotient of ΔQ by ΔM where ΔQ is the sum of the electrical charges on all the ions of one sign produced in air when all the electrons (negatrons and positrons) liberated by photons in a volume element of air whose mass is ΔM are completely stopped in air "

The special unit of exposure is the roentgen (R) It is a measure of the X ray or gamma radiation that will produce $2\,58 \times 10^{-4}$ coulombs per kilogram of air (This unit is numerically equal to the old one defined as "one electrostatic unit of charge per 0 001293 gram of air ')

To define a quantity which could be more directly correlated with the local biological and chemical effects of radiation, the ICRU has recommended the quantity absorbed dose " A special unit of absorbed dose is the "rad " One rad is approximately equal to the absorbed dose delivered when soft tissue is exposed to one roentgen of medium voltage X radiation It is equivalent in en-