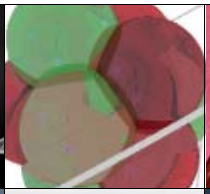
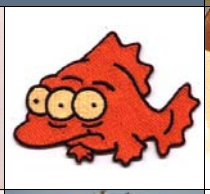




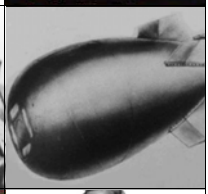
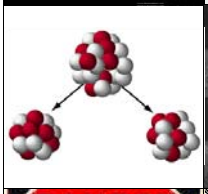

nerdling

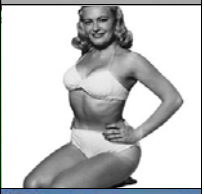
special nuclear issue

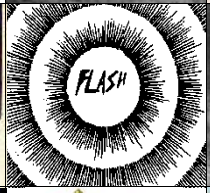







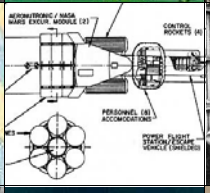




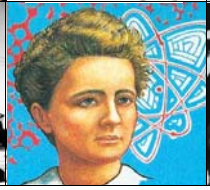
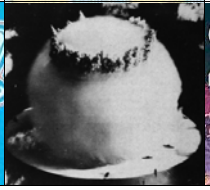
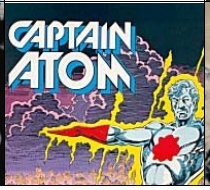









introduction

At **nerdling** we're not afraid to admit that we're shit-scared of the atomic bomb. We're also pretty bloody terrified of nuclear waste being mishandled. But these are issues of politics and management, not nuclear science.

I had a discussion about Chernobyl with an academic the other day, where he said, to substantiate his point that nuclear power facilities are safe, "The system itself was fully under control. It was only because the operators panicked and overrode several safety systems that there was any sort of problem." Inadvertently he hit the nail on the head: every good engineering course stresses that people are just as much a part of the system as any nut or bolt or control computer. And until crazy well-intentioned people stop overriding safety systems, or crazy people stop making more nuclear bombs, or crazy people stop dumping nuclear waste in places where it shouldn't go, then we'll continue to be scared of these things.

However, once the focus moves away from the crazy people and onto the radiation itself, we're in a totally different situation. This is where science empowers us.

The role of science in nuclear issues is the same as in any issue—it is not to deny us the right to moral standpoints and empathic arguments (despite the impression some deadened scientists may give), but rather to allow us to make those arguments stronger by giving us more information. Becoming a scientist does not mean you cease to be a person, and nor does it mean you immediately start pissing off your friends and family by turning single-mindedly pro-nuclear and insisting that they're all uneducated hippies if they disagree. As physicist Erwin Schrödinger put it, the ultimate purpose of science is the same as the purpose of the arts—that is, to answer the question "And we, who are we anyway?" Science is about finding out more about life and the world around us, in order to understand it better. With more knowledge of a physical system, we need to fear it less.

This is particularly pertinent with respect to nuclear science and radiation—both the ionising radiation dealt with in this zine, and non-ionising radiation such as emitted by mobile phones—which are perhaps the most feared and misunderstood areas of science relevant to our daily lives. Because it's invisible, we have to rely on experts to tell us if it's really there. This has elevated the mobile-phone radiation debate to a level where accusations of conspiracies and cover-ups are being made. The same sort of vague fear exists about computer monitors: people I know use radiation filters over their screens 'just to be sure'. And only a few months ago a boy at a local school was exposed to a caesium radiation source he found on the road, which resulted in him being rushed to hospital for a full check-up and the story making national news as a 'radiation scare'—whereas, in reality, you might be able to find a vase in your grandmother's house that's more radioactive than that caesium source (the glaze on old vases commonly contained uranium due to its pretty honey-brown colour). But this didn't stop the story from being a media sensation.

In almost all cases, fear of radiation has done more damage than the radiation itself. Following Chernobyl, thousands of people in Russia were forcibly and permanently moved off their land due to a fear of contamination—when in many places the radiation levels would, in fact, have dropped to near-background levels in only a few days. The suicides resulting from the trauma of losing all their land and heritage took a greater toll on the population than the ra-

diation would have caused. And when the European public heard about the plume from Chernobyl that was carried over the continent, abortions of foetuses skyrocketed—again, unnecessarily.

Remember, radiation itself is not intrinsically bad. It's all around us; right now there is radiation from the earth's crust and from the sun zipping through your body all over the place, not doing you any harm. Your body itself contains Carbon-14 and Potassium-40, which are radioactive particles zapping away at your DNA non-stop—which is why our body has developed mechanisms to deal with most DNA damage from radiation before it goes on to form a cancer. It's the crazy people that are the problem—but that's the case with everything. Remember, the fact that a bloody big asteroid could come and wipe most of the life on earth doesn't mean we have to be afraid of rocks in general. So too with radiation.

This zine does not even try to be a comprehensive guide to radiation. That's what textbooks are for. We've thrown in just enough science to give you a feel for what's going on, and then it's up to you to find out more if you're interested. There are some good references cited along the way for further reading.

Sit back, strap on your weird radiation-proof goggles, and enjoy the zine.

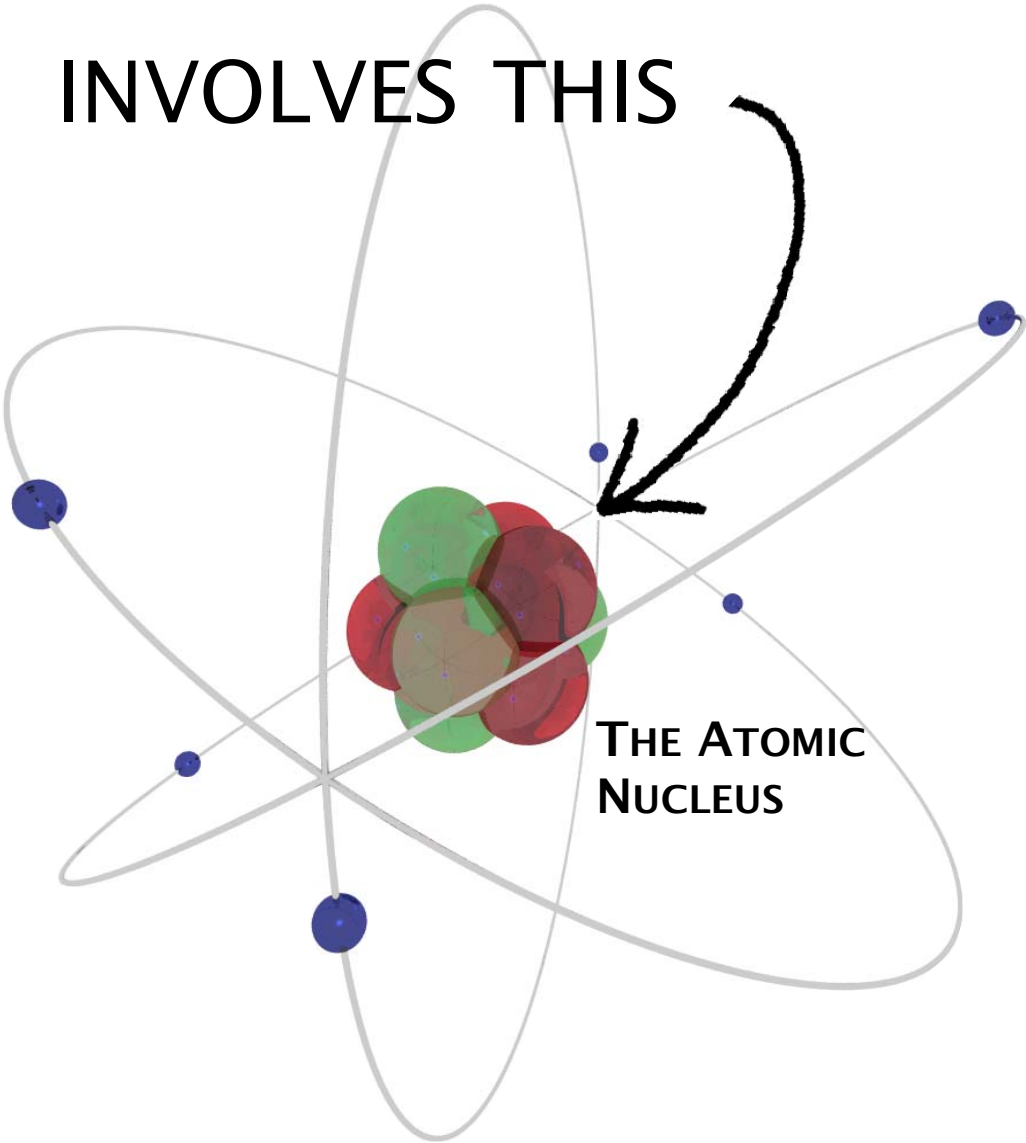
the übernerdling
editor, nerdling zine
january 2004

email: editor@nerdling.net
web: www.nerdling.net

contents

The Reactor

Everything in this issue involves this



The Atomic Nucleus

- The atomic nucleus consists of protons and neutrons (called *nucleons*) tightly packed together. Protons have a positive charge while neutrons have no electrical charge. Both weigh about 1.7×10^{-27} kg; in other words it would take about a thousand million million million million of them to make up a gram.

- The number of protons determines which chemical element the atom is. There are usually at least the same number of neutrons present, and sometimes more. Atoms of the same element, but with different numbers of neutrons, are called isotopes (from the Greek *isos* meaning 'same' and *topos* for 'place' - having the same place in the periodic table).

- Protons and neutrons are about 2 femtometers wide (1fm = 10^{-15}m). If you know *A*, the total number of nucleons, you can find the nuclear radius in femtometers by the formula $R=1.2 \times A^{1/3}$. Using this, we can find that a carbon nucleus is about 2.7 fm wide. The width of the whole carbon atom, by comparison, is about 30,000 times greater. You can see that the picture to the left is hardly drawn to scale.

- The nucleons are held together by the Strong Nuclear Force. It only acts over very short distances of about 1 fm, but is the strongest force known: between two neighbouring protons, the strong nuclear force is about 100 times greater than the electrostatic force and roughly 10^{34} times stronger than the gravitational force.

- It looks fairly innocent. Don't let this fool you.

the one-page guide to radioactivity

For those of us who aren't exactly Marie Curies, we've condensed most of the boring science in this zine to just one page. If you're interested in an introduction to radiation science and measurement, get stuck into the print below. Otherwise, skip over a few pages to where there's some pretty wacky stuff and a few cartoon characters and big explosions to keep you entertained.

Ionising radiation, the stuff we're concerned with in this zine, is nothing but little particles zapping out at you. Mostly these particles are spat out of heavy elements like uranium, or unstable isotopes like carbon-14, both of which would rather exist as something else.

There are many particles which can be considered 'radiation', but most often we're concerned with alpha particles (pretty large, made of two protons and two neutrons), beta particles (a fancy name for flying electrons), gamma rays (just high-energy light), x-rays (more high-energy light) and neutrons.

Radiation can be dangerous to living organisms because it can knock bits out of important molecules. Contrary to popular belief, our bodies are getting zapped with natural radiation all the time. This radiation can occasionally mess with our DNA, but our body is actually pretty good at repairing this damage on the level of day-to-day exposure.

How to measure radiation? Here's where researching radiation can be like trying to navigate through a quagmire using a map written randomly in seven different languages.

There are seven different units for measuring radiation, summarised in the table below, and converting between them is not as easy as you might think. So why is measuring radiation not as straightforward as measuring length or time? Well, unlike length or time we're not only interested in the physical properties of the radioactive substance, but also its effect on humans. This effect varies with the type of radiation, the exposure amount, and the exposure time.

A Geiger counter can register each time one of these particles passes through a given space. This gives a reading in Bequerels (or Curies). However, this measurement will not only vary with the distance from the source but also the size of the detector. It also gives no information about how damaging the particles are to tissue.

The unit Gray takes the energy of the particles into account, and the Sievert takes the energy *and* the level of tissue damage into account. To calculate the dose in Sieverts, one takes the dose in Grays and multiplies it by a 'quality factor' (QF) corresponding to the particles' ability to damage tissue. This factor is exactly 1 for x-rays, approximately 1 for gamma and beta rays, 2-5 for thermal neutrons, about 10 for fast neutrons and protons, and 10-20 for heavy charged particles such as alphas.

As an example, say I want to compare the radioactivity of a barrel of nuclear waste (15 millirem) to the activity of the uranium dye in an old vase I own, which registers 1500 counts per minute on a Geiger counter. To convert the units from counts per minute to millirem is not as easy as you might think. There are actually at least seven different units commonly used to measure radiation. In this case we'd first have to convert the 15 millirem (old unit, like the mile) to Sieverts (new unit, like the kilometre). Then we'd have to find out exactly what kind of radiation the waste was giving out (less easy than you think) and use this to convert to Grays (radiation energy per kilogram of your body), and then to Bequerels (counts per minute). Then you'd have to analyse the type of radiation given off by my uranium vase to find out the proportion of alpha particles, which aren't going to be picked up by the detector (they can't penetrate the casing) and hence need to be mathematically compensated for. By this time the numbers can be compared, but are probably so full of guestimates that it's hardly meaningful anyway.

If you can read this, you're way too enthusiastic.

Table 1: Units Suck

Name	Standard Unit	Old Unit
Activity of Source	Becquerel (Bq) = 1 disintegration/s	Curie (Ci) = 3.7×10^{10} Bq
Absorbed Dose	Gray (Gy) = 1 J/kg	rad = 10^{-2} Gy Roentgen = 8.7 mGy
Dose Equivalent	Sievert (Sv) =(dose in Gy)×QF	Rem = 10^{-2} Sv

Marie Curie: Radiation Pioneer, Total Babe.

Not only did she win two Nobel prizes for her pioneering work on radioactivity, risk her life to build and bring mobile x-ray units to the front lines of the war, and establish the use of radiation in medicine at the expense of her own life, but she lived modestly and always true to her beliefs. A true modern heroine.

Radioactive Jockstraps, Suppositories and Tablets: Cure Yourself Through Radiation!

Nowadays most people have an acute fear of radiation. Mention to a friend that bananas have quite a high level of natural radioactive potassium and it's quite possible that they will think twice before having another banana split. So it can be quite astounding to discover that as recently as the 1980s people were using commercially available radioactive products in the belief it would bring good health.

The idea goes back to the ancient notion that certain springs have healing properties. For thousands of years, people have journeyed to places like Bath in England and Badgastein in Austria seeking cures in the waters there.

When it was discovered around 1903 that the water in most of these springs was slightly radioactive (due to the presence of radon gas in the ground through which the water flows), the world leapt to the conclusion that radiation was the magical healing agent in the springs.

The *American Journal of Clinical Medicine* published the statement that "Radioactivity prevents insanity, rouses noble emotions, retards old age, and creates a splendid youthful joyous life." According to Professor Bertram Boltwood of Yale, radiation cures worked by "carrying electrical energy into the depths of the body and there subjecting the juices, protoplasm, and nuclei of the cells to an immediate bombardment by explosions of electrical atoms" which was, amongst other things, "an agent for the destruction of bacteria".

The Revigator (1920): Irradiate Your Water

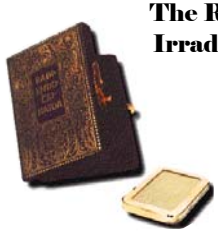
"Results overcome doubts. ... The millions of tiny rays that are continuously given off by this ore penetrate the water and form this great HEALTH ELEMENT—RADIO-ACTIVITY. All the next day the family is provided with two gallons of real, healthful radioactive water . . . nature's way to health."

Radon was believed to be the 'life element' of water. Radon was to water what oxygen was to air. Naturally, entrepreneurs took note—radioactivity was going to be big business.

The problem for people seeking radioactive cures was that radon does not stay in water for very long. After a short period, it decays or escapes into the air, meaning it has to be drunk (or bathed in) at the source. An invention in 1912 aimed to overcome this problem and bring the miracle healing properties of radiation to people everywhere. Called the Revigator, it was a "radioactive water crock" made of radium-containing ore which could hold several gallons of water. The instructions on the side read: "Fill jar every night. Drink freely … when thirsty and upon arising and retiring, average six or more glasses daily." The Revigator Company, based in San Francisco, sold several hundred thousand of these products, which they called "a perpetual health spring in the home."

Many copy-cat products quickly followed. The American Medical Association (AMA) was naturally concerned that the public was being fleeced by charlatans. To prevent this they established guidelines (in effect from 1916 to 1929) for a *minimum* radiation level that was acceptable from these devices. If it was putting out *less than* 2 μCi of radon per litre of water in 24 hours, then you were being fleeced! Even the famous Revigator was not radioactive enough to meet these standards. In Australia, too, certain mineral waters were guaranteed by government authorities to be radioactive.

The Radiendocrinator (1930): Irradiate Your Scrotum



"*Place Radiendocrinator in the adapter . . . wear like any athletic strap . . . under the scrotum as it should be. Wear at night. Radiate as directed.*"

By the 1920s and 30s, it was thought that eating radioactive compounds, or rubbing them directly on to you, could be even more effective than drinking the water. Thus were born radium-containing cosmetics, ear plugs, bath salts, soap, and even suppositories. You could eat a bar of radioactive chocolate, wash it down with a German radioactive beer, and then brush your teeth with radioactive toothpaste. Radium blankets were available to keep you warm at night, and women could wear radium-corsets during the day. Men used radiation treatments to enhance virility, and women used radiation contraceptives in case the mens' treatment unexpectedly worked.

Radithor (1928)

"Harmless in every respect."

The Radiendocrinator (pronounced *Ra*-di-*en*-do-cri-nator), for example, consisted of refined radium encased in 14-carat gold and shipped in a velvet-lined leatherette case for $150—and was designed to be strapped to the scrotum, where it would stimulate the endocrine glands "*which have so masterful a control over life and bodily health*." Also on the market, for only $1 per box of 42, were Radium tablets designed to be taken with each meal. Then there was the Radium Respirator, which enabled you to breath 'radon-purified' air. To quote the manufacturer: "Radium: scientists found it, governments approved it, physicians recommended it, users endorse it, we guarantee it, SURELY IT'S GOOD!"

Radithor was triple-distilled water guaranteed to contain at least 1 microcurie of Radium. Its inventor was William J. Bailey, the same man who brought the world the Radiendocrinator. He proudly used all of his products and claimed to have drunk more radium water than any living man. He died in 1949 of bladder cancer at 64 years of age.

Radithor was advertised as being 'Harmless in every respect." The product slogan proved false in the case of Eben

The Radium Emanation Bath (1925)

Described as being good for nervous disorders, insomnia, general debility, arthritis, and rheumatism. *"Empty contents in a quart of hot water. After a few moments add to regular bath solution. Remain in bath 45 minutes with cover over top of tub. Upon leaving bath relax in bed for one hour."*

Vita Radium Suppositories (1930)

"Weak Discouraged Men! Now Bubble Over with Joyous Vitality Through the Use of Glands and Radium. Properly functioning glands make themselves known in a quick, brisk step, mental alertness and the ability to live and love in the fullest sense of the word . . . Try them and see what good results you get!"

Byers, the Pittsburgh industrialist and one-time U.S. amateur golf champion, who, at the recommendation of his doctor, drank three bottles a day of Radithor for two years. Byers stopped consuming Radithor in 1930 when his teeth started falling out and holes appeared in his skull. He died in 1932 at the age of 51.

After Byers' death, the public and the medical profession became more aware of the dangers of radioactive substances, and new laws were put into place banning most of these products. However, this didn't stop their production. Many products were sold throughout the 50s and 60s, continued to flourish in the 80s, and are still being distributed today.

In the 1960s the Gra-Maze comforter was still being manufactured in Illinois. It was a quilted pad containing uranium ore which could be applied to the body to relieve aches and pains. The company was closed by the government in 1965 following a raid. A similar fate befell the Ionic Research Foundation in Florida, manufacturers of a product to add radon to drinking water.

Another product which continued into the 1960s was the radium-containing Lifestone Cigarette Holder. Inhaling the smoke over the radium was said to diminish nicotine, make the tobacco sweeter and milder, and "protect from lung cancer, promise them beautiful faces, and excellent health."

Degnen's Standard Radioactive Solar Pad (1915-1930)

"Its radioactivity is further increased by exposing the pad to sunlight ... when applied to the body, the pad immediately begins to discharge this energy into the system, sending the lifegiving current through the blood and nervous system."

As recently as 1985 twenty thousand Endless Refrigerator/Freezer Deodorizers were sold in the United States, and are still being sold in Japan today. They consist of a green plastic honeycombed device containing monazite sand, which contains radioactive thorium with a half-life of ten billion years—certainly long enough to justify the 'Endless' name. Users are instructed to hang it in the refrigerator where the emitted radiation is said to purify the air by destroying odours. No details are actually given as to how this is achieved.

Another Japanese product is the NAC Plate, a rectangle about the size of a playing card and coated with

***The* Lifestone Cigarette Holder (1964)**

"Wondrous efficacy of radium emanation protects your health from injurious element in cigarette and makes it sweeter and milder ... [will] protect from lung cancer, promise them beautiful faces, and excellent health."

uranium ore on one side. It is designed to be slipped into a packet of cigarettes where the radiation "denatures and reduces nicotine, tar, and harmful gas" so you can "enjoy … the golden moments of watching smoke rise slowly … with your nerves relieved and refreshed you can get back to work."

Radiation treatments were still recommended by doctors as recently as the 1980s for the treatment of a number of ailments including, amazingly, acne. Patients exist in our hospitals in Australia today who are receiving treatment for cancers likely sustained as a result of these treatments.

The Nicotine Alkaloid Control (NAC) Plate (1980-present)

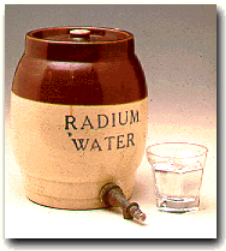
"ions emitted from natural ore denature and reduce nicotine, tar, and harmful gas without affecting the original tobacco taste."

Endless Refrigerator/Freezer Deodorisers (1985)

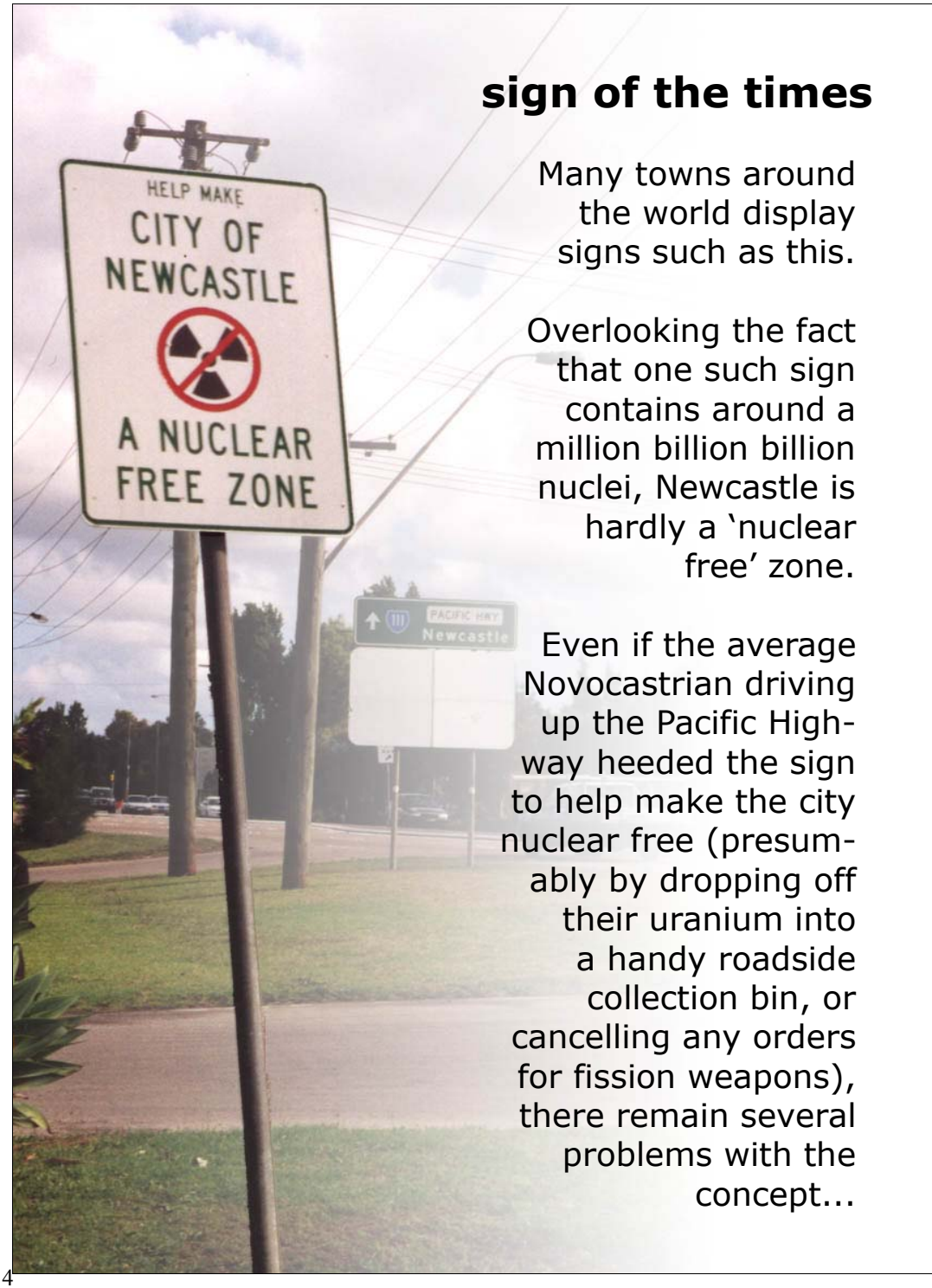
"Natural ion effect destroys odours for years! Outlasts conventional deodorisers. Completely safe."

If you still long for the opportunity to expose yourself to the healing powers of radiation, there is a location in the United States where you can go to obtain a radiation cure. The proprietors of the Uranium Health Mines in Montana are proud of their radioactive air, and promote themselves as "The Free Enterprise Radon Health Mine" with "the unmedical approach to arthritis." Presumably, the wording frees them from the legal constraints of making a medical claim.

You can get a free 'radiation treatment' in the USA just by spending some time in the Rocky Mountain states which, due to their higher altitude and hence lower protection from cosmic rays, have background radiation levels triple that of the Gulf Coast states (and also, surprisingly, has 21 percent less incidence of cancer). Or failing that, you can always go back to basics and take a nice soak in the waters at Bath.



Product information and pictures obtained from Oak Ridge Associated Universities' **Health Physics Historical Instrumentation Museum Collection** at http://www.orau.org/ptp/museumdirectory.htm



sign of the times

Many towns around the world display signs such as this.

Overlooking the fact that one such sign contains around a million billion billion nuclei, Newcastle is hardly a 'nuclear free' zone.

Even if the average Novocastrian driving up the Pacific Highway heeded the sign to help make the city nuclear free (presumably by dropping off their uranium into a handy roadside collection bin, or cancelling any orders for fission weapons), there remain several problems with the concept...

your city is naturally radioactive

you are not 'nuclear free'

Your own body contains radioactive chemicals including potassium-40, carbon-14 and, yes, traces of uranium. Together they zap your body with about 20,000 particles of radiation every second. We do not die from this because of the efficient systems in our bodies for repairing or terminating damaged DNA strands. If you sleep in the same bed as a spouse or partner you can cop an extra 2 microSieverts per year of radiation exposure, equivalent to living within a few kilometres of a 1000MW nuclear power plant.

the sky is not 'nuclear free'

Cosmic rays from space give us all a dose of radiation equivalent to 6 x-rays per year. If you're living higher than sea level, this amount increases because there is less atmospheric thickness to absorb the rays.

the ground is not 'nuclear free'

Uranium is naturally present in Australian earth and coal at a level of one or two parts per million. Each year in Australia, tens of thousands of tonnes of coal are burnt, releasing hundreds of kilograms of uranium into the environment in the resulting ash and emissions. A 1000MW coal-fired power plant is actually two and a half times more radioactive to its surroundings, than a nuclear plant of the same capacity. Ground rock also contains radium, which decays to radon gas which can cause problems by accumulating in poorly ventilated houses and basements.

your food is not 'nuclear free'

Brazil nuts are naturally quite radioactive, as they are rich in potassium and also tend to take up any radium in the soil. Each nut emits one or two radiation particles every second. Bananas are high in potassium and are likewise quite radioactive. A meat-and-three-veg meal can radiate hundreds of particles per second. Tap water emits about one particle per second per litre. If you think drinking natural mineral water will save you then think again: water from underground springs is likely to be more radioactive due to the presence of radon gas.

continued ➡

your city is necessarily radioactive

hospitals are not 'nuclear free'

Newcastle's John Hunter Hospital, like any other hospital, has a nuclear medicine department. If they handed their radioactive sources in to the Newcastle City Council like the sign asks, many people would die from lack of x-ray imaging, tumour-localising agents, cancer-treating radionuclides and the like.

your house is not 'nuclear free'

It is likely your house contains at least one smoke alarm, which contains the radioactive element americium. Other household items can contain radioactive compounds without being labelled as such, for example some fuel lamps are made brighter by surrounding the flame with a wick coated with radioactive thorium. Many pottery and glass vases from the late 1800s up to around 1950 used uranium as a dye in glazes or glassware. (See page 18.)

industry is not 'nuclear free'

Radioactive iridium-192 and cobalt-60 are used in industry to detect flaws in structures and welds by using an imaging method similar to medical x-rays. Other radioactive sources are used to gauge thicknesses of paper, plastic, and metal. Americium is used in oil exploration. Krypton is used for leak testing of sealed electrical components such as transistors. Even New Zealand, proudly and steadfastly a 'nuclear free' country, has used the beta-radioactive isotope carbon-11 in agricultural studies to learn more about photosynthesis in plants.

conclusion

Newcastle City Council wants you to help make the city nuclear free (unless you are a home owner, doctor, builder, engineer, scientist, or if you eat fruit, nuts or meat, or own old vases, or use coal-generated power.) Anyone else can personally hand their radioactive items to the council chambers, where the Lord Mayor will, we presume, most gratefully receive them.

Compute Your Own Radiation Dose

© C. Keay 2001. Reproduced with permission.

Source of exposure		Annual Dose in microSieverts
Because you are you		
Internal Potassium-40 in blood and tissue		100
Other internal isotopes (Carbon-14, Polonium, Uranium etc)		250
What you eat		
Natural radioactivity in food and drink		300
Plus contributions of weapons-test fallout worldwide		15
How you sleep		
With spouse, defacto, partner etc **add** from 1 to 3 (depends on how close, and for how long)		____
How you live		
Medical: **add** number of chest x-rays times 60		____
	no. of gastric tract x-rays times 2,000 to 4,000	____
	number of scans times 1,200 to 24,000	____
	1,000 for plutonium heart pacemaker	____
Dental: **add** number of dental x-rays times 40		____
TV or VDU viewing: **add** 1.5 times number of hours per day		____
Regular hot showers using bore water: **add** 700		____
Jet-setting: **add** 2 per 1000 km travelled		____
Where you live		
Locality:	Coastal sandstone areas	400
	Granite highlands **add** 300	____
Building:	Wooden (assuming half time indoors)	500
	If brick or concrete **add** 200	____
	If poorly ventilated **add** 1,000 or more	____
Cosmic rays:	At sea-level	260
	For every metre of altitude **add** 0.2	____
Coal-fired power generation*:	World-wide contribution	5
	If living near power station **add** 50	____
	If living 10 km from station **add** 20	____
	If living 50 km from station **add** 5	____
Nuclear power generation*:	World-wide contribution	2
	If living near power station **add** 20	____
	If living 10 km from station **add** 1	____

(* 1000 megawatt capacity assumed, and spending half time at home)

Total Dose (minimum about 1,800 in Australia): _____

Compare with an Australian average of roughly 2,000 microSieverts.

Editor's Note: the maximum radiation exposure allowed in Australia for the general public is 3000 microSieverts. For radiation workers it is 20,000. The threshold for harm is about 200,000 microSieverts. 1,000,000 microSieverts (1 Sievert) will cause serious sickness, and 5 Sieverts is enough to kill one-half of a population of healthy individuals.

The table above, and much of the information quoted on the previous two pages, were sourced from Nuclear Radiation Exposed *by Colin Keay, The Enlightenment Press, 2001. Copies are available from P.O. Box 166, Waratah, NSW 2298, Australia, or at www.enlightenmentpress.com.*

Thank You for previewing this eBook

You can read the full version of this eBook in different formats:

- HTML (Free /Available to everyone)
- PDF / TXT (Available to V.I.P. members. Free Standard members can access up to 5 PDF/TXT eBooks per month each month)
- Epub & Mobipocket (Exclusive to V.I.P. members)

To download this full book, simply select the format you desire below