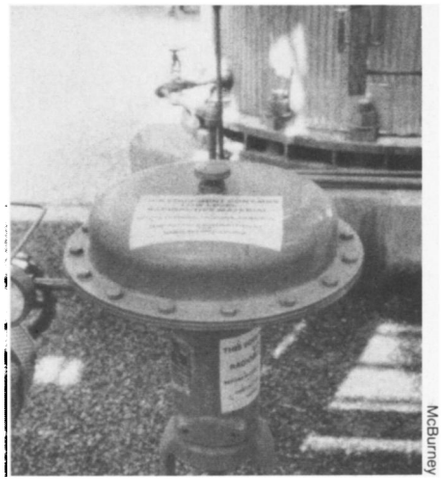
NORM: The New Hot Wastes

States mobilize to fill a gap in federal radwaste management



NORM-contaminated valve at an oil-production facility bears radioactive tag. Such labeling may prevent its eventual disposal as ordinary scrap metal.

By JANET RALOFF

Concerned about the threat of contamination from illegally dumped radiopharmaceuticals earlier this year, the managers of a Pennsylvania landfill increased the sensitivity of the radiation detector used to scan incoming wastes. To their surprise, the first shipment to set off the alarm contained nothing but concentrated brine sludge – a mineral waste produced by oil and gas drilling. The sludge, which arrived in April, contained significant levels of two radium isotopes.

In July, a batch of paper mill wastes tripped the radiation alarm at a scrap-metal yard in Pittsburgh. The mill's operators and Pennsylvania's Department of Environmental Resources (DER) are still puzzling over the source of the uranium in the mill wastes.

Both cases involved naturally occurring radioactive materials, collectively known by the acronym NORM.

Geologists have recognized for decades that NORM could contaminate equipment and wastes at nearly any mineral-extraction site. But because mining engineers suspected that the risk of finding NORM anywhere but in the residues, or "tailings," of uranium and phosphate mining was small, no one systematically sought it elsewhere.

Over the past three years, however, a number of incidents have raised concerns that NORM is ubiquitous – usually in small, diffuse quantities – in many industries traditionally regarded as nonnuclear. Indeed, regulators and waste managers now use the term NORM primarily to describe contaminants produced by such industries.

Because neither waste shipper involved in the Pennsylvania incidents was aware that its goods contained NORM contamination, the shipments were apparently quite legal, says James G. Yusko, a health physicist in DER's Pittsburgh office, who investigated both incidents. Still, these shipments proved about as welcome—and perhaps as innocuous—as a kiss from someone with halitosis.

But nobody's laughing NORM off. Some NORM-contaminated sites and equipment may pose a real health hazard. Moreover, the growing number of related incidents poses political, legal and financial headaches for everyone who encounters NORM, from state officials and industrial-waste generators to waste-treatment operators and metal smelters.

One widely touted remedy for those headaches involves the development of new regulations.

"The American public continues to press for increasingly stringent environmental and public health regulation," observes Linda S. Wennerberg, a regulatory analyst with Arthur D. Little, Inc., in Cambridge, Mass. "This sentiment is especially strong in the areas of radioactive material and waste management."

According to a draft "preliminary risk assessment" for diffuse NORM that the Environmental Protection Agency began circulating in May, "NORM materials are not covered by the Atomic Energy Act of 1954 and are generally not specifically covered by most existing [federal] regulations. Although they are covered by some state regulations, there are presently no universally applicable regulations for NORM materials."

As such, "NORM management represents a gap in the federal regulatory structure, and is currently one of the complex, interdisciplinary regulatory issues emerging in the 1990s," Wennerberg says.

Two years ago, nobody queried the Kansas Department of Health and Environment about NORM, recalls Harold Spiker. But since November, his

What is NORM?

Many unstable elements, created long before our planet's birth, survive throughout Earth's crust. Uranium-238, uranium-235 and thorium-232 parent the three most prevalent families of these natural radioactive materials.

Uranium, present in rocks and soil at concentrations of about 4 parts per million (ppm), is nearly as abundant as lead or molybdenum and more common than mercury or silver; thorium is about three times as prevalent as uranium. As these elements decay into lead, they provide more than 80 percent of the low-level background radiation that continuously bathes humanity.

All soils and rocks harbor radioactive materials, and any activities that concentrate them to levels well above their natural abundance – such as mineral extraction and refining – may potentially create a health hazard. Only now, however, are waste managers and state officials realizing the diversity of industries that concentrate these isotopes in large quantities and to potentially toxic levels.

Regardless of their source, all of these isotopes are NORMs – naturally occurring radioactive materials. However, as it has entered the lexicon of regulators and waste managers, the term NORM generally connotes those radioactive materials that have been concentrated unintentionally to worrisome levels by largely unregulated activities – which basically means anything other than the production of phosphate (principally for agricultural fertilizers) and uranium (for nuclear fuel and weapons). – *J. Raloff*

state radiation control program in Topeka has responded to 20 calls about rail cars and tractor trailers carrying radiation-contaminated wastes, primarily scrap metal. Spiker's investigations indicate that NORM accounted for all but about six of those cases.

Mississippi's experience with NORM dates back to April 1986, when an engineer at an oil field got curious. Having worked on North Sea rigs, where NORM-tainted mineral deposits were first detected in 1981, he decided to pass a portable radiation detector along a pipe as workers withdrew it from a well. At the time, such field surveys were anything but common. To the surprise of everyone present, the pipe readings proved high.

The oil company notified state officials and eventually submitted a sample of "scale," the crusty and potentially occluding mineral deposit that forms along the interior of drilling pipes.

"We started pursuing it from a regulatory standpoint," recalls Eddie S. Fuente, director of Mississippi's Division of Radiological Health in Jackson. Fuente asked the oil company for the name of the machine shop it hired to clean scaly pipe. "We visited it, and sure enough, [NORM-contaminated] scale was right there on the ground," he says. Today, that shop is suing two major oil companies, alleging that NORM contamination from their pipes led to the shop's eventual shutdown. Some shop employees have filed a second suit charging that exposure to NORM-contaminated scale impaired their health.

The episode also prompted state officials to take a number of actions. For example, Mississippi now prohibits the removal of NORM-contaminated scale from oil pipes and gas pipes. Eventually, Fuente says, the state will license firms to undertake such cleaning if they can establish that they will assiduously collect all pipe-cleaning wastes and "either dispose of them properly or turn those wastes back over to the oil companies for them to dispose of."

At present, however, "proper disposal" is a virtual oxymoron, since few places are licensed to accept such wastes.

Ray Turner knows NORM intimately. As a quality engineer for the Cincinnati-based David Joseph Co. — the largest broker of scrap metal in the United States — Turner personally responded to roughly 120 NORM incidents in the first 10½ months of 1991. As of two weeks ago, he was "averaging about one per day." Occasionally, he says, a metal dealer will inadvertently ship a canister containing a potentially intense radiation source that had been licensed for use in medicine or manufacturing. "But of the 454 or so radiation incidents that I've been involved with over the past 3½ years or so, probably 95 percent have been caused by NORM," he told SCIENCE NEWS.

State radiation officers concede they're encountering NORM with increasing frequency these days, but they doubt that this reflects an increase in the magnitude of contamination, say Yusko and others. Most believe they are confronting a problem that simply escaped detection for decades.

No one knows the extent of this problem, although the Environmental Protection Agency is attempting to hazard a guess. Its draft risk assessment points to radium-226, a decay product of uranium-238, as the principal isotope of concern. However, L. Max Scott of Louisiana State University in Baton Rouge has found that oil and gas NORM also contains measurable levels of radium-228, a decay product of thorium-232 — "often about one-third as much radium-228 as radium-226."

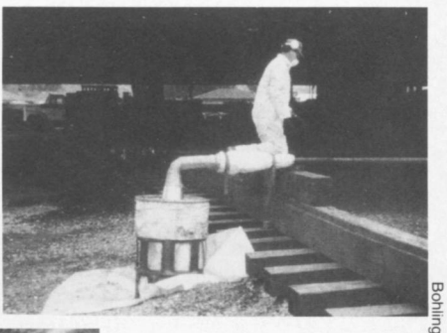
The EPA document says field surveys show that pipe scale from oil and gas drilling can vary dramatically in its NORM content — from undetectable levels to "very high radium-226 concentrations, up to 40,000 picocuries per gram." Other reports indicate that scale can exceed 100,000 pCi/g — a level of radioactivity that's not only roughly 100,000 times higher than typical of soil but also on the low side of what might be encountered in uranium mines (where occupational exposures are monitored and regulated). However, the EPA document points out, researchers have "little or no information" on the volume and actual radioactivity levels of discarded equipment. For its risk estimates, EPA assumes that the radium-226 concentration in scale and sludge averages about 155 pCi/g.

Overall, EPA estimates that most of the NORM-tainted wastes currently generated by oil and gas companies — about 360,000 cubic meters annually — sit in storage awaiting a "proper disposal" strategy. Until recently, generators of these wastes dumped much of it "into nearby surface waters or collection ponds," EPA says in its draft report. Some contaminated oil pipes have even found their way into gym sets, bleachers, fences and other outdoor structures, says L. Hall Bohlinger, who manages radiation-protection programs for Louisiana's Department of Environmental Quality in Baton Rouge. Though Louisiana no longer allows such recycling of these pipes, Bohlinger says his office does not require the dismantling of existing structures as long as the ends of the pipes have been welded shut so that scale can't flake out.

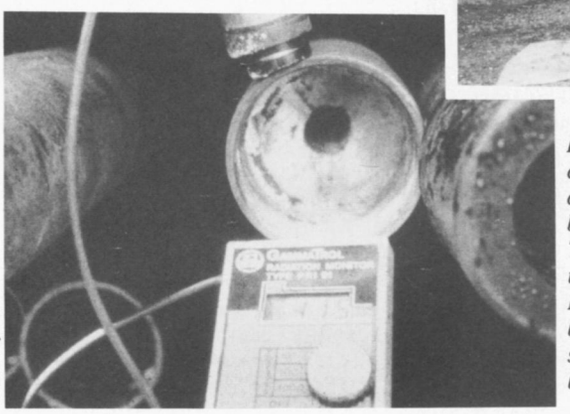
Solid wastes produced from using brine in geothermal energy systems may contain concentrations of radium-226 comparable to oil and gas drilling, EPA's new report says. And some 60 million metric tons of ash produced by U.S. coal burning each year typically bear radium-226 levels that range from less than 1 pCi/g to more than 20 pCi/g. Metal mining and processing may generate 1 billion metric tons of NORM-contaminated wastes annually, but EPA notes that most of this appears to remain in storage at or near the production site.

In general, the EPA analysis suggests, diffuse NORM presents little hazard to most people. Some NORM sources, however, might increase the risk of cancer — especially among workers who inadvertently inhale large amounts of radon decay products or who experience direct, long-term gamma-radiation exposure. "[A] relatively moderate number of [adverse] health effects could result from the improper use or disposal of diffuse NORM wastes," the document warns.

The tremendous uncertainties in the NORM-generation statistics underscore how little regulators know about the distribution of these isotopes and the risks they pose. For example, no one yet has compared how different types of oil-bearing rock or extraction techniques facilitate NORM accumulation on drilling equipment. Health physicists are also



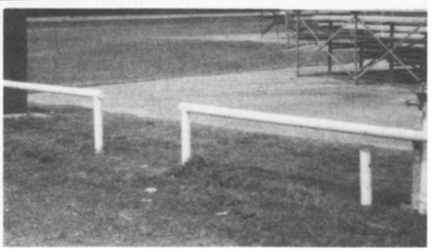
Bohlinger



McBurney

Left: Meter surveys for radiation at the outside surface of an oil-drilling pipe whose interior has been partially occluded by scale. Top: In Louisiana, cleaners vacuum scale scraped from NORM-tainted pipes into filter bags for disposal. Formerly, scrapings were usually just blown onto the ground.

Bohlinger



Oil and gas companies have sometimes donated old drilling pipes to schools and parks. Louisiana has begun surveying the recycled metal for NORM. External surfaces of the NORM-tainted fencing and soccer goalpost shown here emit low but measurable levels of radiation.

seeking reliable analytical techniques for measuring low levels — 5 to 20 pCi/g — of radioactivity at contaminated field sites. And one of the most pressing research concerns involves finding ways to dispose safely of the rapidly accumulating stores of diffuse NORM.

What, then, should waste managers do when they encounter these previously unrecognized NORM sources? Unfortunately, no one can offer a simple answer.

When incoming wastes trigger the radiation monitor at a landfill or steel mill, the shipment is immediately impounded, usually pending an investigation by state health physicists. Then the shippers are notified to retrieve the contaminated material. Waste disposal firms and recyclers are in no position to identify what set off the alarm or to evaluate its potential hazard, Yusko says: If it's radioactive, they don't want it.

What's the shipper to do with it? "I've heard all kinds of horror stories," Turner says. Some have shipped rejected scrap metal to mills that lack radiation monitors — although such mills are becoming harder to find — or to public landfills, he says. "In one incident I know of, material was actually dumped into the Mississippi River."

Several factors underlie such illegal dumping. One common — and incorrect — assumption holds that if these wastes aren't federally regulated, they must be harmless. Turner says some oil-pipe-cleaning crews have carried NORM-contaminated scale in their pockets — "just to show people around the docks that it's not a problem." And their justification, he says, is that if the Nuclear Regulatory Commission (NRC) doesn't regulate this material, it poses no hazard. "People keep telling me, 'NRC says it's not hazardous.' I have to keep telling them that while NRC doesn't regulate it, it's certainly hazardous."

A second incentive for dumping is the low likelihood of getting caught.

Then there's the high cost of getting stuck with such wastes. Many dealers consolidate scrap from dozens, if not hundreds, of sources. If these dealers can't identify who supplied the contaminated wastes (and this is not uncommon), they will have to absorb the round-trip transportation costs — often for the entire load, Turner notes. For a small firm, such costs can seem astronomical.

For example, a rail car carrying the minimum load of 75 to 80 tons can rack up round-trip freight charges of $1,000 to $3,000, depending on the distance traveled, Turner says. And for a barge carrying 1,400 tons, round-trip freight costs could easily exceed $30,000 — in addition to the cost of cleanup. Decontaminating a rail car typically costs from $3,000 to $5,000, he says; cleaning trucks costs about $3,500. Add to that the cost of disposing of the cleanup residues. Such landfilling can cost up to $900 per 55-gallon drum, he says.

In January, Turner's firm asked him to draft a NORM policy to cover all Joseph Co. scrap yards and district offices. He found few federal rules involving the type of NORM typically encountered by scrap dealers. Moreover, the wide discrepancies he uncovered in state requirements made it next to impossible to develop a single policy covering all his company's offices. Those discrepancies have also made the potential shipment of NORM-contaminated wastes across state lines — for return or disposal — a regulatory nightmare.

Speaking for scrap dealers and waste managers saddled with NORM-tainted materials, Turner says: "We're not the ones that make the bad news, just the ones that report it. Unfortunately, we have to pay for the paper [to report it] — and often the cleanup as well."

He would like to see the stream of NORM-contaminated wastes currently circulating in commerce dried up at its source. Instead, there's been a lot of talk about midstream monitoring — "having scrap dealers and scrap yards install [radiation] detection systems," he says.

'Meltdowns' ended NORM's identity crisis

Most NORM-contaminated wastes from traditionally non-nuclear industries are spotted today by accident: They trigger alarms initially intended to alert waste dealers to the illegal disposal of federally regulated radioactive materials — far "hotter" materials that might escape detection because of their concealment inside metal canisters. The escalating number of NORM shipments caught by waste-company radiation monitors testifies to the waste industry's growing fear of getting burned — economically or legally — by its unwitting acceptance of such concealed materials.

Nucor Steel Co. of Plymouth, Utah, learned the hard way. On March 5, 1990, the company contacted the Utah Bureau of Radiation Control to report that a rail car loaded with "frit" — pellets combining fly ash and flue dust from smelting — had tripped a plant radiation monitor.

State officials found that part of the rail car registered roughly 71 times the background gamma-radiation level. Nucor's frit-storage bins registered up to 2,700 times the background gamma-radiation levels, says a report by the Frankfort, Ky.-based Conference of Radiation Control Program Directors.

Cleanup contractors not only had to dismantle one of Nucor's scrap-melting arc furnaces to remove contaminated cinder-like material caked inside it, but also had to decontaminate the plant's exhaust and frit-handling equipment. The total cost: more than $2 million. Barrels containing the 740 cubic yards of refuse from the cleanup still sit at the Plymouth facility awaiting disposal.

What caused this havoc? Probably the meltdown of a sealed canister containing 100 to 150 millicuries of cesium.

Such contamination events are rare but not unique. James G. Yusko of Pennsylvania's DER and Joel O. Lubenau of the NRC are compiling an unofficial list of similar contaminations occurring since 1983. They've already logged 18 mills — dealing in steel, aluminum, lead and copper — in seven countries. The latest inclusion: In August, California and Oregon officials turned up shipments of cobalt-60-contaminated chain-link fencing made by a steel plant in Calcutta, India. — *J. Raloff*

"But you can't dip a river dry by starting in the middle of the river. You've got to start at the headwaters. And those headwaters are mostly oil fields and chemical plants."

But regulators probably won't target those headwaters "until there's an awareness of the magnitude of the problem," he concedes.

Toward that end, Louisiana has initiated a new NORM-surveying requirement for the 10,000 to 15,000 oil and gas producers in that state. Emergency laws enacted in 1989 require that potential handlers or possessors of NORM must survey their property and report their findings. Radiation levels observed outside the pipes reading in excess of 50 microrems per hour (μr/hr) – or about 5 times the normal level of background radiation – will immediately render the site "a general licensee of the state," Bohlinger says. By the end of the year, he adds, the state plans to issue revised regulations that will lower the level triggering state rules to just 25 μr/hr. State licensees not only are subject to personnel radiation-protection requirements but also must store NORM-tainted materials safely until those materials can be disposed of properly.

"In our state," says Bohlinger, "the [waste] generator is not supposed to transport any [NORM-contaminated material] to another location for any kind of disposal or treatment. All they can do is put it in barrels and store it or send it to Utah" – the site of one commercial U.S. facility currently set up to accept NORM wastes. Louisiana, unlike Mississippi, continues to allow oil- and gas-pipe cleaning. However, these cleaners must package and return any NORM-contaminated scale or sludge they find to the drilling company that accumulated it.

This summer, Louisiana and the EPA began a collaborative investigation of risks associated with alternative disposal strategies for NORM. Chief among those under consideration is injecting NORM-contaminated liquids into plugged and abandoned oil wells – essentially returning the NORM to the geological deposits from which drillers inadvertently mined it. Although Louisiana has begun accepting applications for this type of downhole disposal, the practice remains illegal pending an analysis of its potential long-term risks.

At present, Louisiana possesses the only regulations explicitly targeted at nontraditional NORM. But several other states hope to have similar rules by the end of the year. At the annual meeting of the Health Physics Society last July, Ruth E. McBurney, director of licensing and standards for Texas' Bureau of Radiation Control in Austin, explained why Texas and other states want to adopt such rules.

NORM levels currently targeted for state regulation can be hundreds or thousands of times higher than the 5 pCi/g allowed in the top 15 centimeters of soil at uranium mill-tailing sites, she notes. It's inconsistent and unfair to require the cleanup of the low-level wastes from one industry and ignore those from several others, McBurney points out. Moreover, she says, the lack of regulations setting an allowable threshold level of contamination may leave even responsible industries open to lawsuits or unreasonable cleanup expectations.

A committee of the Conference of Radiation Control Program Directors has drafted a set of model state regulations for NORM, which currently await adoption by the whole body.

Growing concern over how best to manage NORM "is likely to result in a comprehensive federal policy with supporting regulation," Wennerberg predicts. EPA's draft risk assessment likewise concludes that the large quantities of diffuse NORM waste "may warrant the implementation of some [federal] regulatory controls."

However, says EPA's William E. Russo, "in the near future, I don't see any indication that we're going to be developing specific guidance for [NORM] disposal" – much less federal regulations. □