It's time to revamp EPA's misleading and incomplete Toxics Release Inventory

Measure Risk, Not Just Emissions

BY GEORGE M. GRAY

INFORMATION CAN BE A VALUABLE AID IN CONFRONTING unreasonable environmental risks. Citizens, companies, and markets need information to evaluate risks and risk-management strategies. Unfortunately, the Toxics Release Inventory (TRI), the most widely used indicator of environmental performance, fails to provide useful information and in many cases may mislead users about environmental risk and companies' efforts to reduce risk. TRI fails because it is an incomplete application of science: it focuses on chemical emissions and not chemical risks, and it provides no context for judging the magnitude of risks that emissions pose to human health or the environment.

BACKGROUND

TRI WAS ESTABLISHED UNDER THE EMERGENCY PLANNING and Community Right-to-Know Act of 1986. For a list of substances maintained by the U.S. Environmental Protection Agency (EPA), facilities in a variety of industries must annually report pounds of emissions to air, water, and land in the preceding year, if emissions are above a specified level. TRI substances are the so-called toxic chemicals; TRI does not cover, for example, such air pollutants as sulfur and nitrogen oxides or particles.

The industry reports, summarized and posted on the Internet by EPA and reported by the news media, often show large quantities of emissions, causing concern among the public and industry. Proponents of TRI suggest that emissions data can inform citizens about potential risks in their communities, guide companies in their efforts to reduce pollution, and cause investors to encourage companies to improve environmental performance.

Although TRI has stimulated much interest in the expansion of right-to-know activities, TRI is the wrong tool to achieve our goals. I will illustrate its shortcomings in the case of the electric utility industry, which this year reports its TRI emissions for the first time. Although the industry will report large quantities of emissions from the burning of coal and oil to produce electricity, those emissions pose little risk to public health. Further, it is clear that the mandated measure—pounds of emissions—is a poor guide to risk management and provides little information for judging environmental performance. TRI should be revamped to measure not just emissions but *risks*.

A CASE STUDY: ELECTRIC UTILITIES

THE RISKS FROM MANY OF THE TRI EMISSIONS BY ELECTRIC utility companies are well known. Assessments by EPA and

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the Electric Power Research Institute (EPRI) have focused on hazardous air pollutants (HAPs), which include almost every type of TRI emission from power plants. Additionally, many utility companies have undertaken their own assessments. I will describe the methods and results of EPA and EPRI's industry-wide assessments, and then I will turn to a site-specific assessment by a utility company.

Assessing the Risks A mathematical model is used to predict the concentration of pollutants (parts per million) in the air around a plant, usually within a 50-kilometer radius. Inputs to the model include data on the plant's emissions, its characteristics (e.g., smokestack height), local geography, and weather (e.g., wind direction and speed).

Given the predicted concentration of a pollutant, the next step is to estimate how much of that pollutant is absorbed by people. EPA's risk assessment focuses on the maximally exposed individual (MEI). The hypothetical MEI lives an entire lifetime outdoors at the place where a pollutant is at its highest concentration. But not everyone—and often no one—lives at the point of highest concentration. Rarely does anyone live in the same place for 70 years. And the assumption of an entire life lived outdoors is pessimistic because, for most pollutants, only a fraction of the concentration in outdoor air becomes part of indoor air.

EPRI, in addition to computing MEI exposure, computed exposures for a reasonably exposed individual (REI). Among other things, EPRI's estimates of REI exposure were based on data about the proportion of time people spend indoors, the penetration of pollutants to indoor air, and the average length of time a person lives near a power plant (19 years).

Estimates of MEI exposure were significantly higher than estimates of REI exposures—5 to 12 times higher for the point of greatest pollutant concentration.

Risk at the MEI or REI level of exposure depends on the toxicity of a substance. EPA's and EPRI's risk assessments focused on long-term exposure and used standard EPA methods to characterize potential cancer risks and risks of other adverse health effects. Both EPA and EPRI focused only on the chemical nature of the pollutants. Some pollutants, especially the gases, might have different estimates of risk if their particulate nature was also considered.

For a noncarcinogenic substance, risk is characterized by a hazard quotient (HQ). HQ is the ratio of estimated exposure to a reference concentration (RfC) or reference dose (RfD), an EPA-determined level at which no adverse effects are expected with lifetime exposure, even among potentially sensitive subpopulations such as children and the elderly. HQ is not a probability. It is a ratio of estimated exposure (lifetime dose) to an apparently safe level of exposure.

For a substance with carcinogenic potential, exposure is multiplied by a cancer "slope factor" to yield estimates of the increased probability of developing cancer as a result of exposure to the compound in question. Standard procedures for cancer risk assessment yield what EPA terms "a plausible upper bound" on risk, reminding us that "the true risk is likely to be lower and may be zero."

EPA and EPRI Risk Assessments The risks from power plant emissions vary according to the fuel they use. Both EPA and EPRI analyzed coal, oil, and natural gas plants separately. Natural gas is the cleanest fuel and emissions from gas plants were so low that detailed analysis was not conducted. (Not surprisingly, gas-powered plants are exempt from TRI reporting.) Emissions from coal- and oil-fired power plants were analyzed more carefully.

Both EPA and EPRI found that human exposures to HAP emissions from power plants were always well below RfC (or RfD) for noncancer effects. Even MEI exposure estimates were always less than 10 percent of RfC. For the majority of compounds, MEI exposures were hundreds or thousands of times less than RfC, regardless of the fuel used by a plant. Both EPA and EPRI concluded that power plant TRI emissions do not pose a risk of noncancer effects, even accounting for exposures to people living in areas subject to emissions from several plants.

The TRI program only tells the public about pounds of emissions. Clearly, that information is insufficient and potentially misleading.

EPA and EPRI examined two measures of cancer risk from HAPs: (1) individual risk, the increased probability (above background) of an individual developing cancer due to the exposure; (2) population risk, the annual excess number of cancers in an exposed population. The maximum individual risk (calculated from MEI exposure estimates) varied with a plant's fuel, location, age, and other factors.

According to the EPA report, *all* power plants had lifetime maximum individual risks of cancer below $1X10^{-4}$ and more than 97 percent had risks below $1X10^{-6}$ (less than one-in-one million). Of 426 coal-fired plants, 44 had a maximum individual risk below $1X10^{-8}$, 289 were between $1X10^{-8}$ and $1X10^{-7}$, 91 were between $1X10^{-7}$ and $1X10^{-6}$, and 2 plants had maximum individual risk estimates between $1X10^{-6}$ and $1X10^{-5}$. Of 137 oil-powered utilities, 26 plants had maximum individual risk below $1X10^{-8}$, 48 were between $1X10^{-8}$ and $1X10^{-7}$, 52 were between $1X10^{-7}$ and $1X10^{-6}$, 9 were between $1X10^{-6}$ and $1X10^{-5}$, and 2 plants were between $1X10^{-5}$ and $1X10^{-4}$. Further, the EPA report suggests that the risk to the average person in the United States from hazardous air pollutants emitted by utilities is 100 to 1,000 times lower than the calculated maximum individual risk.

In all cases, there were very small risks to populations around power plants. For example, even EPA's analysis concluded that the upper bound risk to all people living within 50 kilometers of the 426 coal-fired power plants in the United States was no more than 0.2 cases of cancer per year.

EPA's and EPRI's HAP risk assessments do not completely overlap the list of TRI chemicals. Several substances that utilities will report under TRI were not included in the HAP assessments (e.g., barium, copper, molybdenum, and zinc). In addition, HAPs for several power plants will not be reported under TRI because emissions are below the benchmark set by the Community Right-to-Know Act.

A Utility's Self-Assessment A major eastern utility company recently assessed short-term and long-term health risks from emissions of TRI-listed substances by its large coal-fired plants. I will take as an example the company's risk assessment for its largest TRI-emitting plant, which in 1997 burned almost 7 million tons of eastern coal and produced more than 16 billion kilowatt-hours of electricity (approximately equal to the total demand of Maine, New Hampshire, and Vermont).

Using MEI exposure estimates modeled by the company, I calculated HQ and cancer risks for that plant, using standard EPA methods and, where available, EPA values for exposure limits. In the absence of official EPA values, I used exposure limits from California's EPA or the American Conference of Governmental Industrial Hygienists. I focused on risk from direct inhalation of power-plant emissions.

Table 1 gives TRI emissions and risk estimates for the plant. The data for TRI emissions are similar to what will appear in the local newspaper when EPA releases its TRI emissions report for 1998. But, unlike EPA's report, we see in Table 1 the risk estimates for each type of emission and the sum of HQ and cancer risks for all emissions. Not shown in the table is the assessment of acute risks—the number of immediate deaths caused by emissions—which was less than 0.04 in total.

An examination of Table 1 yields two key insights: the risk from emissions is low and there is a poor correlation between pounds of emissions and risk.

Risks in Context Even at MEI exposures, all HQs for noncancer risks are far below the assuredly "safe" level of 1. All cancer risk estimates—which in EPA's terminology are "plausible upper-bound estimates"—are less than $1X10^{-6}$ (one in a million), the level considered "negligible" by regulatory agencies. Compare that level of risk with other involuntary risks: $1X10^{-6}$ is ¼ of a person's lifetime risk of being killed on the ground by a falling aircraft and 1/100 of the lifetime risk of being struck by lightning or drowning in a home bathtub. Recall that the true value of the cancer risks, to quote EPA, "is likely to be lower and may be as low as zero."

Table 1

TRI Emissions and Associated Chronic Risks from Example Power Plant

Compound	TRI Emissions (pounds/year)	MEI Noncancer Hazard Quotient	MEI Individual Cancer Risk
Antimony	360	8.57E-07	
Arsenic	3,640	4.00E-03	2.58E-07
Barium	820	4.57E-06	
Beryllium	380	3.00E-04	1.44E-08
Chromium	500	2.60E-05	3.12E-08
Cobalt	160	1.91E-06	
Copper	940	1.42E-05	
Hydrochloric acid	5,172,000	2.18E-03	
Hydrofluoric acid	46,480	9.75E-05	
Lead	960	4.43E-06	
Manganese	180	6.00E-05	
Molybdenum	500	6.40E-05	
Nickel	300	6.00E-06	3.12E-11
Selenium	6,860	3.96E-04	
Sulfuric acid	2,915,200	5.36E-04	
Zinc	1,360	2.80E-06	
TOTAL	**8,150,600**	**8.00E-02 (0.008)**	**3.04E-07 ($3.04X10^{-7}$)**

Note: Hazard Quotients are in scientific notation. For example, the HQ for antimony is $8.57X10^{-7}$, or 0.000000857, indicating an exposure approximately 1.16 million times lower than RfC or RfD. An HQ of less than 1 is considered assuredly safe. A cancer risk of less than $1X10^{-6}$ is considered negligible by regulatory agencies.

Emissions and Risks The EPA, EPRI, and industry studies yield several lessons about the relationship between emissions and risks. First, as I noted, there is a poor correlation between emissions and risks. Large numbers of pounds of emissions are often associated with very small risks, even at MEI exposure levels. It is important to note, however, that certain compounds with MEI risks that might be of concern (i.e., cancer risks greater than $1X10^{-6}$) are not reported in TRI because emissions are below the reporting threshold. That is, small numbers of pounds of emissions can be associated with potentially notable levels of risk—a relationship that TRI, in its present form, does not recognize.

Second, we see that pounds of emissions is a poor guide to environmental performance. Even relatively large emissions may be associated with no risk. Yet TRI reports play a large role in many rating systems. For example, *Fortune* has based a story ("Who Scores Best on the Environment?" July 26, 1993) on TRI emissions. The Council on Economic Priorities, which grades companies on

several social criteria as a guide to investors, uses TRI emissions as an important component of its evaluations of environmental performance. Similarly, Domini Social Investments uses TRI emissions in making its decisions about companies in which to invest.

Further, despite TRI's known shortcomings, many companies rely on it to describe their environmental performance and to guide their actions. Many a company's "annual report on the environment" and press releases will focus on the sum total of its TRI emissions—a measure that almost every company knows to be scientifically indefensible. Of course, industry is simply reacting to the incentives that have been created: credit and status as a "good corporate citizen" go to those who reduce emissions, regardless of the effect on risks to health.

A third lesson from our case study is about the methods of the health risks caused by emissions. Why use methods that purposely overstate risks when we should be trying to assess actual risks? As I noted, EPRI's analysis found significant differences between maximum and reasonable exposure estimates. And EPA has suggested that maximum risk estimates might overstate average risk by 100 to 1,000 times. Deliberately inflated estimates of risk do not tell the public what it needs to know or help companies to choose their best courses of action.

CONCLUSION AND RECOMMENDATIONS

A Better System Is Needed The TRI program tells the public only about pounds of emissions. Clearly that information is insufficient and potentially misleading. Few citizens have the time or means to apply the science necessary to make sense or use of TRI reports.

The use of TRI to guide facilities' risk-management efforts may be counterproductive. Efforts to reduce the largest emissions may provide little or no benefit to human health or the environment, especially if smaller and possibly riskier emissions are ignored. Investors assessing environmental performance may focus on the wrong companies, processes, or chemicals.

In sum, the public and industry will be served better by placing right-to-know information on a sound scientific footing. Revamping the TRI program to report risk as well as emissions would be a step in the right direction. But there would still be the problem of potentially hazardous compounds that are not emitted in sufficient quantities to trigger TRI reporting. The solution to that problem is *not* to lower the reporting threshold, which would only flood the TRI system with emissions data on even more substances of negligible risk so as to include a few that might merit attention.

Any improved system must provide context to judge the magnitude of the risks of TRI emissions against other risks. Without context, even a risk-based approach can lead to confusion and inefficient risk management.

A Better Alternative: Significant-Risk Reporting Given its serious shortcomings, TRI should be revamped. Instead of reporting pounds of emissions for selected compounds, facilities should report *all* emissions above a *significant-risk* cutoff. If facilities reported only emissions with cancer risks above $1X10^{-6}$ or HQs above 0.10, for example, their reports would be much more meaningful and useful to citizens and industry. Reporting on emissions of all types also would eliminate the perverse incentives that arise from list-based approaches to risk management (e.g., encouraging the substitution of unlisted chemicals for listed ones).

A significant-risk system of reporting would require agreed risk-assessment methods and oversight to ensure compliance with those methods. But such a system would have several benefits. First, citizens would be informed if there were significant—or negligible—risks from nearby facilities. Second, pollution-prevention activities could be focused on important emissions, not the easiest to reduce. Emission reductions under TRI show that corporations respond to incentives; significant-risk reporting would ensure that *risks* are reduced.

Finally, the availability of risk information would give investors a sound basis for assessing the environmental performance of companies. If investors value risk information, firms would have an incentive to reduce the environmental and health risks that they report. And if risk reduction increases a firm's value, its management would have an incentive to make costly investments in efficient methods of risk reduction. Companies that cannot or will not reduce significant risks would face the prospect of embarrassment, consumer boycotts, and lower stock prices.

Closing Thoughts We should not retain a system that lacks scientific validity and misleads those it is intended to help. TRI must be overhauled to focus on risk, rather than emissions. It will take hard work and hard thought to produce risk-based right-to-know information, but the result will be more useful and scientifically sound information for all.

READINGS

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