ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

ATSDR's Evaluation of Iodine-131 Releases From the Oak Ridge Reservation: A Summary

RADIOACTIVE IODINE

Iodine consists of both radioactive and nonradioactive forms, referred to as isotopes.

I-131 is the most important radioactive isotope released to the environment from the RaLa process at the X-10 site.

I-131 travels through the air and can contaminate soil, water, plants, and animals.

Goats and cows, especially those raised in backyards or in local pastures closest to the X-10 site, could have concentrated iodine in their milk.

Drinking milk is the most important way in which people might have been exposed to I-131 released from the X-10 site.

What Do We Know About Iodine-131 Releases from the Oak Ridge Reservation?

In 1942, the federal government established the Oak Ridge Reservation (ORR) in Tennessee's Anderson and Roane Counties. By 1943, the government had built the X-10 site on the ORR.

Figure 1. The Clinton Pile Building, later known as the Graphite Reactor, was located at the X-10 site, now referred to as the Oak Ridge National Laboratory (ORNL).

Known formerly as Clinton Laboratories, X-10 was a pilot plant to show how plutonium could be produced and separated. From 1944 to 1956, a major effort at the X-10 site was the production of radioactive lanthanum (RaLa). During the RaLa manufacturing process, a byproduct known as radioactive iodine was released into the air, primarily from the dark-colored stack shown in Figure 1. The RaLa manufacturing process was the most significant source of iodine-131 (I-131) releases at the ORR.

In an effort to determine the extent of I-131 releases from ORR's X-10 site, in July 1999 the Tennessee Department of Health (TDOH) released the *Reports of the Oak Ridge Dose Reconstruction, The Report of Project Task 1: Iodine-131 Releases from Radioactive Lanthanum Processing at the X-10 Site in Oak Ridge, Tennessee (1944-1956)—an Assessment of Quantities Released, Off-Site Radiation Doses, and Potential Excess Risks of Thyroid Cancer* (referred to as the Task 1 report). The Task 1 team reviewed historical records of RaLa operations at the X-10 site and estimated I-131 releases from 1944 to 1956. The models developed by the Task 1 team predicted that I-131 releases were most highly concentrated in the communities of Gallaher Bend and Bradbury, downwind of the X-10 site. The maximum concentration of I-131 in these communities was predicted to be about 5.5 picocuries per cubic meter (pCi/m^3) in air—about four times higher than the I-131 airborne concentrations measured in the city of Oak Ridge.

Additional Historical Environmental Monitoring Data

The Agency for Toxic Substances and Disease Registry (ATSDR) also reviewed two sets of historical monitoring data related to the RaLa process at the X-10 site. These data were discovered after the TDOH's Task 1 report was released. The data include:

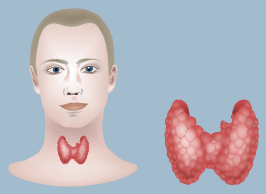
1) Results of continuous air monitoring covering much of the early and mid-1950s for locations at or near the X-10 site.
2) Results of iodine-129 (I-129) concentrations, another form of radioactive iodine, measured in the thyroids of deer from 1979 to 1989 from on-site locations and off-site areas near the ORR.

The continuous air monitoring data and the I-129 deer thyroid data provide strong evidence that RaLa releases of radioactive iodine did not extend beyond the X-10 site boundary at levels that would constitute a public health hazard. It is important to note, however, that the environmental monitoring data have certain limitations, which add some uncertainty to any conclusions drawn from them.

HEALTH CONCERNS ASSOCIATED WITH RADIOACTIVE IODINE

With a half-life of approximately 8 days, I-131 decays rapidly and gives a large radiation dose to the thyroid gland in a short amount of time.

The thyroid gland is at the base of the neck. It secretes hormones necessary for growth and proper metabolism.



Once I-131 is ingested, the body easily absorbs it. Approximately 30 percent of the I-131 ingested is deposited in the thyroid.

Exposure to I-131 radiation often affects cells in the thyroid gland, leading to certain types of thyroid diseases, including thyroid cancer.

People exposed to I-131, especially as children (less than 18 years of age), may have an increased lifetime risk of thyroid disease.

Other health effects that may be linked with I-131 exposure include autoimmune and cardiovascular disease. But compared to the well-documented adverse effects on the thyroid, the association between radioactive iodine and other health effects is much less certain.

Another form of radioactive iodine important in the RaLa process is I-129. The half-life of I-129 is about 15.7 million years. Although I-129 remains in the environment for a very long time, the rate of decay is very low, limiting the radiation dose to the thyroid and limiting the potential for health effects. Before much of the I-129 decays, bodily processes remove it from the thyroid.

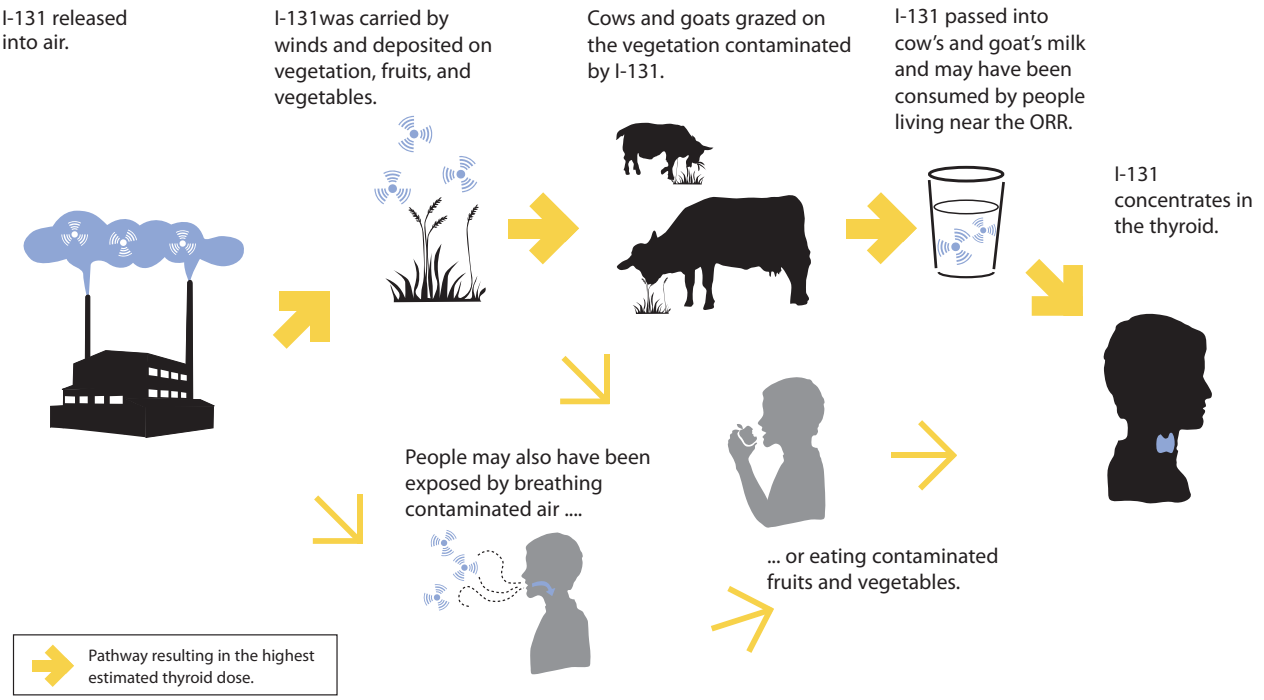
What Was the Extent of I-131 Exposure for People Living Near the ORR?

The Task 1 team used mathematical models and health-protective assumptions to develop estimates of I-131 taken up by plants and animals and to predict the I-131 doses for people living in communities near the ORR. A number of different pathways were identified (e.g., drinking local cow's and goat's milk, eating locally grown vegetables, and breathing air) by which people could have been exposed to radioactive iodine (see Figure 2). Populations potentially exposed to I-131 were identified and unique factors that would influence the extent and duration of peoples' exposures were also determined. Several factors were identified as primary contributors to a person's I-131 exposure and to the corresponding risk of developing thyroid disease. These factors include:

- **Diet**—Dose reconstruction models predicted that in all likelihood, an individual's diet contributed most to the amount of I-131 taken into the body. Drinking milk was one of the most important ways in which people might have been exposed to radioactive iodine. Goats and cows, especially those raised in backyards or in local pastures closest to the source (the X-10 site), had concentrated levels of iodine in their milk and were a potential source of exposure for residents. Possibly some radioactive iodine exposure, though in much smaller amounts, also resulted from eating eggs, beef, other dairy products, and leafy vegetables.
- **Location**—The dose reconstruction models predicted that I-131 releases could have affected a study area as far as 24 miles from the X-10 site. The highest radiation doses to the thyroid gland were estimated for individuals living in Gallaher Bend, a town about 3.5 miles east of the X-10 site. The historical environmental monitoring data recently evaluated by ATSDR suggest, however, that RaLa releases of radioactive iodine from the X-10 site did not travel beyond the X-10 site boundary at levels that would constitute a public health hazard. Consequently, the off-site areas affected by X-10 radioactive iodine releases could have been much more limited.
- **Age**—Children under the age of 18 typically absorb higher doses of I-131 than do adults and drink more milk than do adults. A child's thyroid gland (the gland in which iodine concentrates in the human body) is smaller than an adult's. Because radiation doses depend on organ mass, the effect of I-131 uptake is greater in children. In addition, children are more sensitive to the effects of I-131 in their bodies than are adults.
- **Year of Birth**—In general, individuals born in years when the highest I-131 releases occurred were predicted to receive the highest doses. For example, highest doses were estimated for people born from 1944 to 1952, whereas lower exposure doses were associated with birth years 1920, 1930, and 1956.

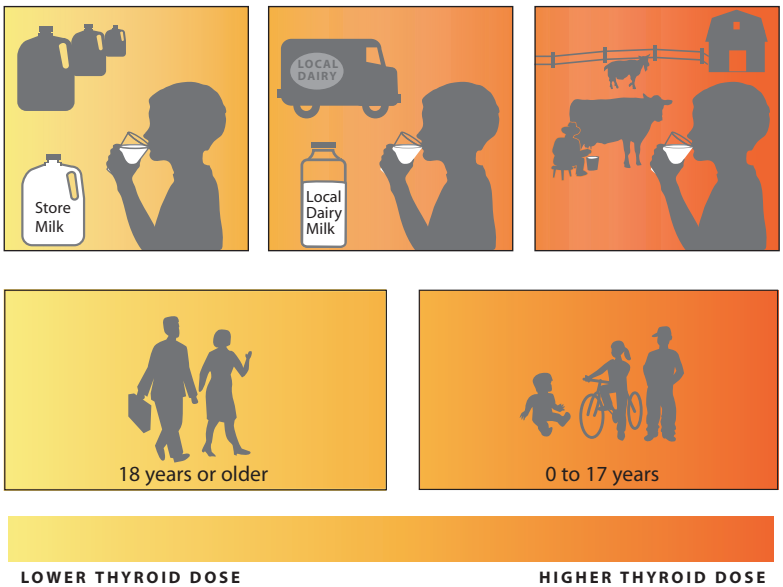
Figure 2: How Were People Exposed to I-131 from the X-10 Site?

During the RaLa processing at the X-10 site from 1944 to 1956, people living in communities near the reservation received most of their exposure to I-131 from drinking contaminated milk.



Location

The Task 1 radiation dose estimates to the thyroid indicated that I-131 from X-10 RaLa processing may have impacted areas as far as 24 miles from the X-10 site. Factors such as prevailing winds and atmospheric dispersion, along with estimated I-131 releases, were considered in the models to predict ground-level air concentrations of I-131 at different locations. These estimated ground-level air concentrations were used to estimate radiation doses to the thyroids of hypothetical individuals at each location evaluated by the Task 1 report. The recently identified historical monitoring data provide strong evidence, however, that I-131 releases did not extend beyond the X-10 site boundary at levels that would constitute a public health hazard.



Milk Consumption

Drinking backyard cow's or goat's milk resulted in higher estimated radiation doses to the thyroid than drinking milk obtained from a local commercial dairy. Drinking goat's milk contributed more to an individual's estimated thyroid dose than drinking backyard cow's milk. Much lower thyroid doses resulted from drinking milk obtained from a market that sold milk obtained from regional distributors.

Age of Resident

Infants and children who were less than 18 years of age at the time of RaLa processing are the most susceptible populations because their thyroids typically absorbed higher amounts of I-131 than an adult's and they drank more milk than adults.

What Conclusion Did ATSDR Reach About Potential Health Effects Related to I-131 Released from ORR's X-10 Site?

Current and Future Exposures

Since 1991, no significant amounts of radioactive iodine have been released into the air from the ORR. ATSDR does not expect any current or future exposures to radioactive iodine from this site. Any I-131 released from the X-10 site during the 1940s through 2005 has decayed completely or is currently not present in the environment at levels that constitute a health hazard.

Past Exposures

RaLa processing at the X-10 site released radioactive iodine from 1944 to 1956. People who lived near the ORR in the past might have come in contact with radioactive iodine in the food they ate (drinking local cow's and goat's milk) or in the air they breathed. Insufficient information is currently available to make a definitive public health statement regarding the potential for health effects from past I-131 releases for those who were under age 18 at the time of RaLa processing.

Because of limitations with the available data, ATSDR is unable to satisfactorily determine the extent to which off-site communities were impacted by past I-131 releases from the X-10 site and whether exposures occurred at levels sufficient to cause harm. Consequently, we are *unable to reach a definitive conclusion* regarding the potential for health effects from past I-131 exposures.

After reviewing the current literature and recently discovered historical monitoring data, ATSDR did, however, conclude the following about past radioactive iodine exposures:

- Persons who were under the age of 18,† who lived near the ORR during the years of RaLa processing, and who may have received a thyroid radiation dose in excess of 10 rads, were the critical-sensitive population with the potential for developing thyroid diseases, including thyroid cancer. However, because of insufficient information about the actual areas impacted by RaLa releases, ATSDR cannot identify which communities surrounding the X-10 site may have been impacted in the past by thyroid doses in excess of 10 rads.
- Persons who were at least 21 years of age† during the years of RaLa processing were not exposed to I-131 at levels that would have induced thyroid diseases, including thyroid cancer.
- Historical air monitoring and the deer thyroid data strongly suggest that I-131 released into the environment from RaLa processing from 1944 to 1956 did not extend beyond the X-10 site boundary at levels sufficient to cause health effects. These past data were only recently identified and were not available at the time of TDOH's Task 1 report.

† The literature regarding health effects is inconclusive for individuals 18 to 20 years of age.

Recommendations

ATSDR recommends collecting soil samples downwind and upwind of ORNL (on- and off-site) and analyzing these soil samples for I-129. Although I-131 released from X-10 RaLa processing is no longer present in the environment, the current radioactivity of I-129 in soil can be used to evaluate past I-131 concentrations. ATSDR believes that data collected for this I-129 analysis can be used to reduce the uncertainties associated with the estimated thyroid doses in the Task 1 report and to better define the off-site populations potentially impacted by I-131 releases. As a prudent public health practice, ATSDR recommends that residents who lived in the potentially affected communities and were 18 years or younger between 1944 and 1957 discuss the need for thyroid exams with their local physician.

Where Can I Get More Information?

You can get more detailed information on I-131 releases from the RaLa process at the X-10 site from ATSDR's Web site at *http://www.atsdr.cdc.gov/HAC/oakridge/phact/index.html*. You may also contact ATSDR toll free at 1-800-CDC-INFO (1-800-232-4636) or contact Paul Charp (phone: 770-488-0723, email: *pcharp@cdc.gov*) or Jack Hanley (phone: 770-488-0736, email: *jhanley@cdc.gov*).