In October 1990, Congress passed the Radiation Exposure Compensation Act (RECA) to compensate people (or their surviving beneficiaries) who have been diagnosed with specified cancers and chronic diseases that could have resulted from exposure to agents associated with the nuclear-weapons testing carried out for more than 20 years during and after World War II.

Eligible claimants include civilian onsite participants involved in aboveground nuclear-weapons tests at various U.S. test sites, downwinders who lived in areas currently designated by RECA, and miners employed in underground uranium mines who meet specified residence or exposure criteria. Uranium millers and ore transporters living in RECA-designated areas at the time of testing were added to the list of eligible claimants in July 2000.

The Health Resources and Services Administration (HRSA) oversees the Radiation Exposure Screening and Education Program (RESEP) that provides screening, education, and referral services for RECA populations. In response to a congressional mandate, HRSA asked the National Research Council to make recommendations on: 1) improving accessibility and quality of medical screening, education, and referral services in the RESEP program; 2) whether recent scientific information related to radiation exposure and associated diseases could improve services for exposed persons; and 3) whether additional groups of people or geographic areas should be covered under RECA.

The report recommends that RECA be more scientifically based; Congress should establish a new process based on science to determine eligibility for federal compensation. Because residents outside current RECA-eligible areas may have been exposed to higher amounts of radiation than those in currently eligible areas, this process should apply to all residents of the continental US, Alaska, Hawaii, and overseas US territories who have been diagnosed with specific RECA-compensable diseases and who may have been exposed, even in utero, to radiation from U.S. nuclear-weapons testing fallout. However, because the risks of radiation-induced disease are generally low at the exposure levels of concern in RECA populations, in most cases it is unlikely that exposure to radioactive fallout was a substantial contributing cause of cancer.

As is already the case with uranium miners, the report recommends that all uranium millers and ore transporters with RECA-compensable diseases living in the United States, not just those living in RECA-designated areas, should be eligible for RECA.
Box 1. What is ionizing radiation?

When radioactive elements decay, they produce energetic emissions that can cause chemical changes in tissues. The average person in the United States receives a "background" dose of about one-third of a rad* per year. Different types of radioactive materials emit different types of radiation:

**Gamma rays or X-rays** travel long distances in air and can pass through the body, exposing internal organs. For RECA populations, gamma-ray exposure could have resulted from the radioactive fallout from nuclear testing.

**Beta radiation** can travel a few yards in air and in sufficient quantities might cause skin damage; it can be hazard if ingested or inhaled. For RECA populations, beta-radiation exposure is primarily from ingestion of $^{131}\text{I}$ in contaminated milk.

**Alpha radiation** travels only an inch or two in the air and cannot even penetrate skin, but is a hazard if it is ingested or inhaled. For RECA populations, alpha radiation exposure is a concern for uranium miners, millers, and ore transporters who have inhaled radon particles.

* A rad is a measure of radiation dose. 100 rad = 1 Gray (Gy)

How Exposure is Estimated

RECA populations could have been exposed to external (gamma and beta) radiation from bomb testing and fallout and internal (alpha and beta) radiation from either inhalation or ingestion of radioactive materials (see Box 1). Individual exposure to fallout is affected by several factors including where people live, hours spent outdoors, and consumption of contaminated milk.

There is a collection of data that maps external and internal exposure rates across the United States. However, dose estimates depend on measurements of radioactive elements taken at the time of the nuclear weapons tests at a very small number of monitoring stations, so the estimates have been interpolated over very large areas. Data shows that doses from external radiation to radiosensitive tissues are small and, in all but a few cases, not significantly greater than those from natural background radiation (CDC-NCI, 2001).

The most important pathway of exposure is the ingestion and inhalation of radioactive iodine ($^{131}\text{I}$) through the consumption of milk (NCI, 1997). Iodine is absorbed rapidly in the gastrointestinal tract and taken up by the thyroid gland. There has therefore been an extensive effort to determine the dose to populations from $^{131}\text{I}$ originating in the aboveground nuclear testing. The decade-long effort has produced a dose calculator that can conveniently be used to estimate the dose to a person on the basis of age, location, and milk consumption (NCI, 1997) (http://ntsi131.nci.nih.gov/).

Figure 2 shows estimated thyroid dose from both external and internal sources to children born in 1951. Estimates of the absorbed dose, measured in a unit called Gray (see Box 2), range from 0–100 milliGray (mG).

For uranium miners, millers, and ore transporters, the primary concern is inhalation of radon, a naturally occurring radioactive gas, produced from uranium decay, that emits alpha particles. Those exposures are estimated from the length of time they were on the job.

Health Risks of Radiation Exposures

Risks for Downwinders and Onsite Participants at US Nuclear Tests

Risk estimates for human cancer development from exposure to radiation come mainly from cancer mortality data on the survivors of the atomic-bomb detonations at Hiroshima and Nagasaki. (NRC, 1990; ICRP, 1991; NCRP,
Those studies are particularly reliable because of the very large, well-defined study population, excellent long-term follow-up, and the fact that there are good estimates of individual doses. The main finding from follow-up studies in Japan is that radiation increases the risk for most types of cancers, basically in proportion to radiation dose. However, radiation is a relatively weak carcinogen. The mean dose of all survivors was about 0.2 Sieverts (roughly 20 rad). For this group, there is about a 10% increased risk of solid cancers beyond normal age-specific rates. For those who received radiation doses from 0 up to 10 rad, less than 1% of cancers in that population were attributable to radiation. Most downwinders received far lower doses of external radiation exposures than atomic-bomb survivors.

Studies of populations occupationally exposed to radiation including nuclear testing fallout at the Nevada Test Site, the Marshall Islands, and the Smepalatinsk Test Site in Kazakhstan. 

Studies of people exposed to environmental releases of radioactive iodine near nuclear plants, and people who are occupationally exposed. Studies of the Chornobyl accident show that the largest increase in absolute thyroid cancer risk has been in children who were under 5 years old at the time of the accident, with a progressive decrease in observed risk to age 18 years (Thomas et al., 1999). The Hanford Thyroid Disease Study (HTDS), mandated by Congress in 1988, studied thyroid disease among people exposed to radioactive iodine from the Hanford site from 1944-1957. There was no evidence of a statistically significant increase in any of the thyroid diseases studied with increased radiation dose (Davis et al., 2004b).

Studies of people occupationally exposed to radiation provide a way to compare data from atomic-bomb survivors, who were exposed to an acute (all-at-once) dose, with populations chronically exposed to radiation (over time), as is the case with RECA populations.

A comprehensive reassessment of risk estimates for exposure is included in a companion, forthcoming report from the National Research Council, Biological Effects of Ionizing Radiation VII (BIER VII).

**Health Risks to Uranium Workers**

Epidemiologic studies of underground miners have identified an increased risk of primary lung cancer associated with exposure to alpha-particle radiation from decay products of inhaled radon (NRC, 1988). The most recent and widely recognized risk estimates associated with radon exposure were reported in the BIER VI report (NRC, 1999). Other recent studies on mining populations (e.g., Roscoe, 1997) provide support for the current list of RECA-compensable diseases.

Risks to the health of uranium millers and ore transporters from occupational exposure have not been as well characterized as the risks to miners’ health because of smaller sample sizes and little or no data on individual exposures. Studies of millers from the Colorado Plateau (Archer et al., 1973, later expanded by Waxweiler, et al, 1983) found no statistically significant increased relative risk of mortality from any malignancies, but did find increased risk from nonmalignant respiratory disease. Two more recent studies (e.g., McGeoghengan and Binks, 2000a & 2000b) provided information on uranium workers exposed to uranium coming from the mills.

The study committee is unaware of any epidemiologic studies of ore transporters. Like the millers’ exposure, their primary potentially hazardous exposure was to ore dusts, probably with a greater risk of chemical toxicity than radiation toxicity. It is unlikely that their exposure to radiation from the ores substantially exceeded normal background levels.

**Proposed Changes to the RECA Program**

**Expanding RECA Eligibility**

New information since RECA was enacted in 1990 reveals a wider geographic distribution of dose from 131I than was generally recognized when Congress identified selected counties as affected areas for downwinder eligibility as illustrated by Figure 2. Evaluations made by the report’s authoring committee in 2003 showed that persons living in states and counties at the time of the nuclear testing outside those currently designated by RECA could have received as high or higher thyroid doses as did those living in areas specified in RECA (NRC, 2003c). Because of those inconsistencies, the current report recommends that RECA eligibility should not be limited to its current geographic boundaries. Instead, a new scientific reassessment should be used to extend the ability to apply for RECA to all residents of the continental US, Alaska, Hawaii, and overseas US territories who have been diagnosed with specific RECA-compensable diseases who may have been exposed, even in utero, to radiation from U.S. nuclear weapons testing fallout. 

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**Box 2. Assessing Risk to Health from Radiation Exposure**

Knowledge of the types and magnitudes of health risk to onsite participants and downwinders is built on studies of several populations that have been at risk of exposure to similar ionizing radiations. Those populations include:

- Atomic-bomb survivors at Hiroshima and Nagasaki, Japan.
- Populations exposed to nuclear testing fallout at the Nevada Test Site, the Marshall Islands, and the Smepalatinsk Test Site in Kazakhstan.
- Studies of people exposed to environmental releases of radioactivity from nuclear plants including Chernobyl and the Hanford site.
- Studies of populations occupationally exposed to radiation including nuclear-industry workers, nuclear shipyard workers, and medical personnel.

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131I
The Proposed New Pre-Assessment

Currently, persons applying for RECA must provide documentation of their disease and their residency during the time of the testing, and employment records. For much of the RECA population, the first step is to go to HRSA for screening and subsequent documentation.

In order to provide guidance to potential claimants as to whether they might qualify for RECA before they undergo medical screening, the report recommends that the National Cancer Institute or other appropriate agencies should perform a population-based preassessment of all radiogenic diseases using an approach known as probability of causation/assigned share (PC/AS) that is widely used in other compensation programs. The preassessment is intended to encourage only the submission of eligible applications in order to improve the efficiency of the administrative process and to reduce delays in awarding compensation.

Congress should set new eligibility criteria. Because of substantial gaps in existing data and other factors, the PC/AS process carries large uncertainties. Congress faces the challenge of deciding if it's best to define criteria that avoids rewarding compensation in cases in which there is low risk of a disease, but where uncertainty is large because the connection of these cancers with radiation is not well established or the estimated doses are not well known.

The implementing agencies should post and distribute to the public the lists of groups and populations that are identified in the preassessment. Each individual application must also be assessed using the PC/AS process.

Cancers and Diseases Covered by RECA

Box 1 lists the populations and diseases currently covered by RECA. Based on a thorough review of the most recent scientific literature, the report recommends that, at this time, the evidence is still not sufficient to support the addition of other cancers or diseases under RECA.

Improving the HRSA RESEP Program

The report makes several recommendations regarding improving HRSA’s Radiation Exposure Screening and Education Program with regard to improving the accessibility and quality of medical screening, education, and referral services that include the following:

- Once an individual has been shown to be administratively eligible for compensation under RECA (including employment, residence, or a calculated PC/AS at or above some established cutoff criterion), HRSA should offer medical screening recommended in generally accepted protocols that apply to the population at large.

- If an individual has established eligibility for compensation, RECA should cover the costs of screening, complications of screening, referrals (follow-up), diagnosis (workup), and treatment for the RECA-compensable diseases for which such eligibility has been established.

- HRSA should provide information to RECA populations about other radiation exposure compensation programs for which they might be eligible. An advisory organization should compare similarities and differences with other federal compensation programs related to radiation exposure; HRSA should periodically convene representatives of all programs to address inconsistencies among programs and determine the effects of developments over time in radiation biology, risk estimates, legislation, and regulations.

- HRSA should ensure that all public informational materials are written so that members of target populations can understand their contents and undertake an enhanced program of education and communication about the risks posed by radiation exposure from fallout from US nuclear-weapons testing.