

# Neutron detectors

## Alternatives to using helium-3

### Why GAO did this study

Neutron detectors are used to detect neutron radiation in science, security, and other applications. For example, large-area detectors detect neutrons at science facilities across the world and radiation portal monitors screen vehicles and cargo at ports and border crossings for nuclear material that terrorists could use in a nuclear weapon. Helium-3 is a critical component of such neutron detectors, and in 2008 the U.S. government became aware of a severe shortage of helium-3 gas. While demand for it has increased, helium-3 is currently produced as a byproduct of the radioactive decay of tritium, and the United States ceased tritium production in 1988. The shortage has led science facilities and federal agencies such as the DOD and DHS to identify or develop alternative detector technologies.

GAO was asked to review the effectiveness of alternative neutron detector technologies that do not use helium-3. GAO assessed (1) what alternative neutron detectors are currently available and their effectiveness, and (2) the status of research on alternative neutron detector technologies under development for future availability. GAO reviewed agency documents and interviewed agency officials and detector developers. With assistance from the National Academy of Sciences, GAO also assembled a group of experts to review and advise on this study.

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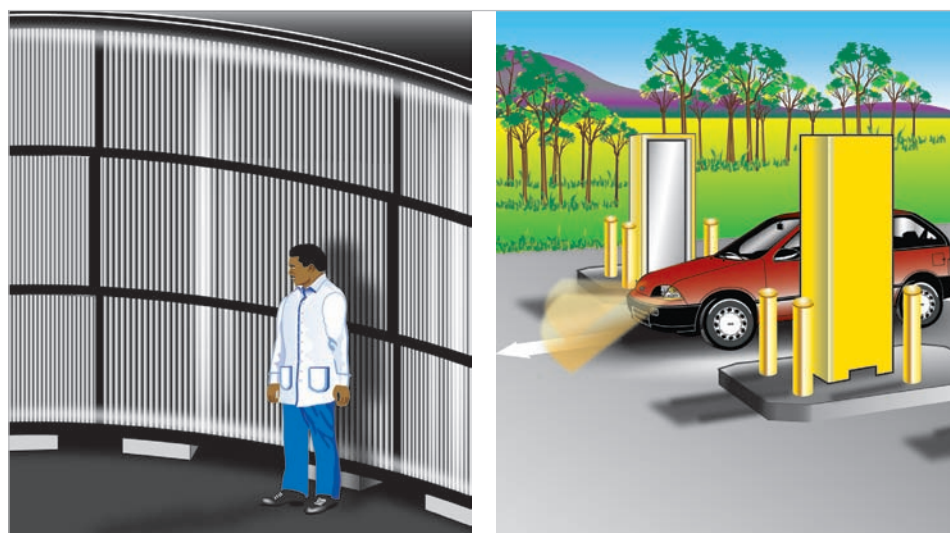
### Report multimedia

Neutron detector animation:  
[www.gao.gov/products/GAO-11-753](http://www.gao.gov/products/GAO-11-753)

### What GAO found

Science facilities and federal agencies are working to determine the effectiveness of currently available alternative neutron detector technologies for use in large-area detectors and radiation portal monitors (RPM)—the two neutron detector applications that have created the greatest demand for helium-3. An international collaboration of science facilities that plan to deploy large-area detectors for research and federal agencies that procure and deploy RPMs for security have identified three alternative neutron detector technologies that are available and might satisfy requirements for use: boron-10 lined proportional detectors, boron trifluoride proportional detectors, and lithium-6 scintillators. These technologies use boron-10 and lithium-6 rather than helium-3 to detect neutrons. The international collaboration has agreed on a plan to develop and test large area detectors using these technologies. Federal agencies, such as DHS, have been directing the testing of these technologies for use in RPMs, and field testing of RPMs using boron-10 lined proportional detectors has been completed. According to agency officials, a boron-10 lined proportional detector may be available for domestic RPM deployments in early fiscal year 2012. GAO estimates this neutron detector is sufficiently mature such that a decision to use it in forthcoming portal monitor deployments can be made with confidence that the portals will perform as required. Our estimate is based on our assessment of the technology readiness levels (TRL), which assess the maturity of an application on a scale of 1 to 9. We found these three currently available alternative neutron detector technologies range in TRL from 5 to 7.

Federal agencies are funding more than 30 research and development programs that may result in additional alternative neutron detector technologies. At varying stages of research, these programs focus on security applications but may eventually be applied to other neutron detector applications. Some of these technologies may become available for integration into deployable detector systems in less than two years and could potentially help reduce demand for helium-3.



Neutron detectors: a large-area detector (left) and a radiation portal monitor (right).  
Source: GAO.

We provided a draft of this report to Commerce, DOD, DOE, and DHS. They generally provided technical comments that we included as appropriate.