New report examines molybdenum-99 production and use

September 12 2016

Although the current supply of molybdenum-99 and technetium-99m - isotopes used worldwide in medical diagnostic imaging - is sufficient to meet domestic and global demand, changes to the supply chain before year-end could lead to severe shortages and impact the delivery of medical care, says a new report by the National Academies of Sciences, Engineering, and Medicine.

The congressionally mandated report examines the production and utilization of molybdenum-99, technetium-99m, and associated medical isotopes iodine-131 and xenon-133, and also assesses the progress made in eliminating highly enriched uranium (HEU) from molybdenum-99 production.

Technetium-99m - derived from molybdenum-99 - is the most commonly used isotope for radionuclide medical imaging, which noninvasively evaluates regional physiologic and metabolic processes, such as cardiac blood flow, with the ultimate goal of localizing diseased tissues and organs.

Nearly 95 percent of the world's supply of molybdenum-99 is produced by irradiating targets - typically a solid plate containing uranium clad in aluminum - in seven research reactors located in Australia, Canada, Europe, and South Africa. This isotope has not been produced in the U.S. since the late 1980s. Molybdenum-99 and technetium-99m are distributed through an international supply chain on a weekly or more frequent basis. Such speedy delivery is essential because molybdenum-99 and technetium-99m have short half-lives and therefore cannot be stockpiled.

The report finds that while current global supplies of molybdenum-99 are adequate to meet U.S. needs, the capacity to supply molybdenum-99 will be reduced substantially when the reactor in Canada stops production at the end of October 2016. Canada will then become a supplier of last resort - producing molybdenum-99 only in case of severe global shortages - until its reactor shuts down permanently at the end of March 2018.

The committee that conducted the study and wrote the report said that there is a substantial likelihood of severe molybdenum-99 and technetium-99m shortages after October 2016, should any of the other current suppliers fail, and lasting at least until other global suppliers complete their planned capacity expansions, currently scheduled for 2017. The committee recommended that the U.S. government continue to work with the Canadian government to ensure that there is an executable and well-communicated plan in place to restart the supply of molybdenum-99 from Canada between October 2016 and March 2018, if needed.

"Current efforts to increase the supply of molybdenum-99 by expansion of existing overseas production and initiation of domestic production by methods not requiring highly enriched uranium are important to ensure future availability," said committee chair S. James Adelstein, Paul C. Cabot Distinguished Professor of Medical Biophysics at Harvard Medical School. "Although there are plans from both existing international suppliers and potential domestic suppliers to fill the expected supply gap from Canada, the committee is concerned that any delays in bringing additional supplies of molybdenum-99 to the market would increase the risks of substantial shortages."

The U.S. currently consumes about half of molybdenum-99 produced worldwide. However, demand in the U.S. has been declining for at least a decade and has decreased by about 25 percent between 2009-2010 and 2014-2015. The committee judged that domestic demand is unlikely to increase significantly over the next five years, while international demand could increase primarily because of higher utilization in Asian markets.

The report notes that the American Medical Isotopes Production Act of 2012 and financial support from the U.S. Department of Energy's National Nuclear Security Administration have stimulated private-sector efforts to establish U.S. domestic production of molybdenum-99 for medical use. However, no domestic commercial production will be established before Canada stops producing molybdenum-99 after October 2016. The report also says that potential domestic suppliers face technical, financial, regulatory, and market penetration challenges. The market challenges will likely increase after current global molybdenum-99 suppliers expand production.

About 75 percent of the world's supply of molybdenum-99 is currently produced using targets containing uranium enriched to greater than 90 percent uranium-235 - referred to as weapons-grade HEU - that could be used to construct nuclear explosive devices. Most of this HEU is of U.S. origin. Converting molybdenum production to targets using low enriched uranium (LEU) - uranium enriched to less than 20 percent uranium-235 - would remove HEU from civilian use and reduce the risks that it could be used for illicit purposes. The report says that four of the five global molybdenum-99 suppliers have committed to converting from HEU to LEU reactor targets and are making uneven progress toward that goal. Conversion could be completed by the end of 2019 if current schedules are met.

The report says that the Russian Federation has indicated its intention to become a global molybdenum-99 supplier in the future. It currently produces molybdenum-99 with HEU targets and has not announced a commitment or schedule for converting to LEU targets for production. The report cautions that the continued sale of molybdenum-99 produced with HEU targets to international markets could disrupt progress toward full market adoption of molybdenum-99 from non-HEU sources. The report recommends that the U.S. government—through the U.S. Department of State, the U.S. Department of Energy's National Nuclear Security Administration, and the U.S. scientific and technical communities—engage with the Russian government to clarify its schedule for converting molybdenum-99 production from HEU to LEU targets.

The report also raises concern about the large quantities of wastes containing HEU that have accumulated from several decades of molybdnenum-99 production and will continue to exist at multiple locations even after the use of HEU is eliminated from production. This concern also was raised in a 2009 congressionally mandated Academies report that examined the technical and economic feasibility of producing medical isotopes without HEU. The U.S. government is working with global suppliers and their governments to examine options for downblending - for example diluting HEU with natural uranium - or returning this material to the U.S. The committee recommended that the U.S. government work with global molybdenum suppliers and their regulators to reduce the proliferation hazard from processing waste from medical isotope production containing U.S.-origin HEU, and that it develop a global inventory of this waste if one does not already exist.

More information: www.nap.edu/catalog/23563/moly … -for-medical-imaging