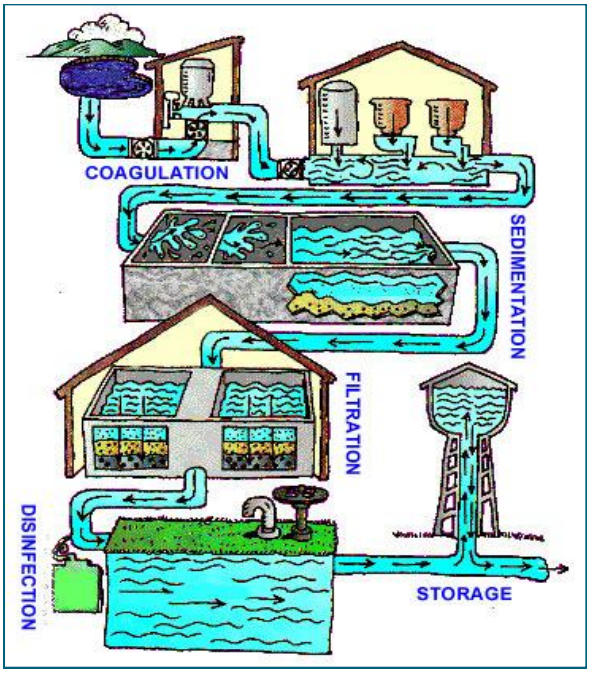
TENORM Associated with Drinking Water Treatment

This fact sheet covers elementary aspects of the potential problems, regulatory issues, and, ultimately, prevention of exposure and environmental contamination by Technologically Enhanced, Naturally Occurring Radioactive Materials (TENORM). Many operators may not be generally aware that Naturally Occurring Radioactive Materials (NORM) can be concentrated by water treatment systems. Furthermore, if operators do not manage filtering components in a way that limits radioactivity, workers and the public could be exposed, and licensable quantities of TENORM may be produced.

NORM, such as uranium, radium and thorium, is present in the environment in soils, air, and water. To address NORM in drinking water, the U.S. Environmental Protection Agency (EPA) revised the Radionuclides Rule in 2003 requiring Community Water Systems to comply with the Maximum Contaminant Level (MCL) for radium 226/228 combined and the new MCL for uranium 238. Water systems in certain areas of the country have high levels of NORM and have had to implement additional treatment options to remove the radionuclides from the water. Treatment of the water with even moderate levels of NORM can concentrate the radionuclides in the residuals at a level of concern and needs to be managed.

Residuals are categorized as resins, membranes, filter media, sludges, and liquids. Liquid residuals include brines, concentrates, backwash water, rinse water, and acid neutralization solutions. Spent resins, filters, and membranes generally contain concentrated levels of radioactivity that may need to be sent to a facility approved for disposal of radioactive materials. A specific radioactive materials license could be required if the radioactivity exceeds State and/or Federal regulatory limits.

Alum based residual
(courtesy U.S. Department of Agriculture)



Typical Treatment System (courtesy U.S. EPA)

At large plants, alum (aluminum sulfate), ferric chloride or other chemicals are added to raw water, forming a gel that gradually coagulates or flocculates to the bottom of the tank as solid waste. Radionuclides precipitate with solids efficiently. Sedimentation and filtration usually follows coagulation. Activated carbon, sand, diatomaceous earth, greens and membrane filters are all used in combination with fluoridation and chlorination. These filtering components may be backwashed and/or regenerated a number of times but must ultimately be replaced.

Smaller systems can treat radionuclides and other contaminants with reverse osmosis, ion exchange or softening. These treatment technologies generate solid waste as resins and membranes that may contain elevated levels of TENORM.

Managing Drinking Water Residuals

To manage or possibly reduce the potential for radioactivity in the residuals, operators need to take into consideration several factors, including the concentration of radionuclides in the source water; the efficiency of the treatment at removing radionuclides; the frequency of regeneration; the frequency of backwash; the frequency of resin, media, or membrane replacement; and loading to the treatment system. If radionuclides are a potential issue, pilot tests can be conducted to determine how best to manage or reduce radioactivity in the residuals. Facilities should conduct planning and modeling to avoid activity levels (particularly of radium) that will require disposal in licensed radioactive waste disposal sites.

Depending on your local and State regulation, there are a number of options for disposal of drinking water treatment solid or liquid radioactive residuals. The primary factor in determining a disposal option is the concentration of radioactive materials in the residual. Depending on the concentration of TENORM, solid or sludge residuals may be disposed at municipal solid waste landfills, monofills, industrial landfills, hazardous waste landfills, uranium mill tailings impoundments, and commercial low-level radioactive waste disposal sites; however, each increasing level of protection comes with increased costs and regulatory oversight. Liquid residuals containing TENORM may be disposed of by direct discharge to waters, discharge to a publicly owned treatment works, or underground injection with the appropriate permits or approvals.

A System's Guide to the Management of Radioactive Residual from Drinking Water Treatment Technologies (EPA 816-F-06-012, August 2006) has more information regarding disposal options for radioactive residuals.

A Regulators' Guide to the Management of Radioactive Residuals from Drinking Water Treatment Technologies (EPA 816-R-05-004, July 2005) has information on treatment efficiencies, modeling, and management. It also has a decision tree that can help you choose a disposal option.

Always contact your local regulatory agency before choosing a disposal option as additional requirements may apply depending on agency regulations, disposal facility restrictions, and waste characteristics.

Health and Safety

It is important to ensure that radioactivity from drinking water treatment residuals does not enter the environment at levels above regulatory limits. It is especially important to look at environmental concerns when radioactive residuals are being disposed. Environmental monitoring may be necessary during the operational phase and in the post-closure phase of a facility where radioactive residuals are disposed.

Water treatment facilities where radioactive residuals are being generated should prepare a radioactive residuals management plan to ensure that residuals are properly contained and a plan for cleanup of any spills. If radioactive residuals are properly contained within the facility, members of the public should not be exposed to radiation or come in contact with radioactive materials. In the event of an accidental release of radioactive residuals, the levels of radioactivity found in this type of waste present very little hazard to the public.

The three basic pathways for exposure to workers are direct exposure to, inhalation of, and ingestion of radioactive materials. A radiation exposure survey should be conducted to evaluate direct exposure to workers from radiation. Time, distance, and shielding can be used decrease worker exposure. Risk of inhalation or ingestion of radioactive materials can be reduced by using basic industrial hygiene practices to avoid contact with radioactive materials. Radon measurements may also be warranted. Workers at water treatment facilities where radioactive residuals are being managed generally conduct activities that do not cause them to be exposed to TENORM. Workers whose activities may bring them in contact with radioactive residuals should be trained in basic radiation safety. A suggested training outline may be found in Appendix E of the Colorado Department of Public Health and Environment's TENORM Policy and Guidance.

Regulatory Framework

There are no uniform national guidelines or regulations for management of TENORM. Management of TENORM falls under various regulatory authorities including the U.S. EPA, the U.S. Nuclear Regulatory Commission (NRC), and the authority of individual States. Additional information on the U.S. EPA's regulations and guidance regarding TENORM can be found at http://www.epa.gov/rpdweb00/tenorm/regs.html. Additional information about the NRC's regulations can be found at http://www.nrc.gov/materials.html. Individual State regulatory guidelines can be obtained by contacting the State's radiation program. Contact information for each State's radiation program may be found at the website for The Conference of Radiation Control Program Directors (CRCPD) at http://www.crcpd.org.

References

Association of State and Territorial Solid Waste Management Officials. Incidental TENORM: A Guidance for State Solid Waste Managers, April 2011. http://astswmo.org/files/publications/federalfacilities/2011.04_FINAL_ASTSWMO_TENORM_Paper.pdf

Colorado Department of Public Health and Environment. *Policy and Implementing Guidance for Control and Disposition of Drinking Water Treatment Residuals Containing Technologically Enhanced Naturally Occurring Radioactive Material (TENORM),* February 2007. http://www.cdphe.state.co.us/wq/drinkingwater/pdf/TENORM/TENORMDraftGuidance.pdf

Conference of Radiation Control Program Directors. "Detection and Prevention of Radioactive Contamination in Solid Waste Facilities" (Publication 98-3), E-23 Committee on Resource Recovery and Radioactivity, March 1998. http://crcpd.org/PortalTools/Shopper/ProductDetail.cfm?ProdCompanyPassed=C3&ProdCdPassed=C3-98-3&quantityPassed=1

Health Physics Society. *Control and Release of Technologically Enhanced Naturally Occurring Radioactive Material (TENORM);* ANSI/HPS N13.53-2009. http://hps.org/hpssc/n13standards.html

United States Environmental Protection Agency (U.S. EPA). *A Regulators' Guide to the Management of Radioactive Residuals from Drinking Water Treatment Technologies*, (EPA 816-R-05-004), July 2005. http://www.epa.gov/rpdweb00/docs/tenorm/816-r-05-004.pdf

U.S. EPA. *A System's Guide to the Management of Radioactive Residuals from Drinking Water Treatment Technologies* (EPA 816-F-06-012), August 2006. http://www.epa.gov/ogwdw/radionuclides/pdfs/guide_radionuclides_systemsguidetoradioactive.pdf

US. EPA. *Radionuclides Rule: A Quick Reference Guide,* (EPA 816-F-01-003), June 2001. http://www.epa.gov/ogwdw/radionuclides/pdfs/qrg_radionuclides.pdf