Conventional Mills vs. In Situ Recovery Facilities

When requirements for uranium milling were initially established in the 1980s, uranium ore was processed primarily at conventional mills. Although uranium *in situ* recovery (ISR) facilities existed at that time, the primary concern leading to the enactment of the Uranium Mill Tailings Radiation Control Act of 1978, as amended, was contamination from the tailings piles at conventional mill sites. As a result, the U.S. Environmental Protection Agency and the U.S. Nuclear Regulatory Commission (NRC) regulations are primarily focused on the prevention, detection, and correction of contamination from mill tailings impoundments at conventional mill sites.

Historically, mills using the conventional process received uranium ore in the form of mined rock that was crushed and leached to remove and concentrate the uranium. The leftover rock (tailings) from this process is a sand-like material that was consolidated into large unlined piles and left onsite. Tailings are typically contaminated with hazardous constituents that were naturally present in the ore and those used in the uranium extraction process, including heavy metals, solvents, and radionuclides that were freed up but not removed during the milling process.

In the 1990s, ISR technology became the predominant means of producing uranium in the U.S. The licensed area of a typical uranium ISR facility covers several square miles and may include several discrete or contiguous wellfields, some of which may be operating while others may be in restoration or decommissioning. Each ISR wellfield is composed of a series of injection and extraction wells drilled into a uranium ore body that has been identified in a subsurface geologic formation as well as other support and ancillary infrastructure within the wellfield. The ISR technology eliminates the steps of mining ore, transporting it to a mill, crushing it, and using chemical means (such as sulfuric acid) to dissolve the uranium. Instead, the ISR technology relies upon chemical leaching that occurs underground in the ore body itself. A leaching solution (lixiviant) containing oxygen and/or bicarbonate is pumped through injection wells into the production zone aquifer in the ISR wellfield where the ore body is located. The injection of lixiviant induces a chemical change in the ore body that frees the uranium from the host rock. The lixiviant then carries the uranium to the surface through production wells. On the surface, an ion exchange process is used to remove the dissolved uranium from the lixiviant. The lixiviant is then pumped back to the ore body. The ISR process does not generate tailings, but it does produce waste streams containing Section 11e.(2) byproduct material that require proper management. The proper management of liquid wastes from ISR facilities includes engineered controls such as evaporation ponds, deep disposal wells, land application, and unrestricted effluent releases allowed under the Table 2 limits in Appendix B to Part 20 of Title 10 of the *Code of Federal Regulations*. Solid wastes such as sludges and contaminated equipment from ISRs are transported offsite to existing mill tailings impoundments. These waste disposal management practices prevent contamination of the environment and ensure compliance with radiation dose limits for the public.

The surface production facilities of ISR operations (e.g., ion exchange columns, evaporation ponds), and wastes produced in the ISR wellfield by the production and extraction operations (e.g., waste liquids, soil contaminated from spills), are either under the NRC's regulatory authority (for ISR facilities located in non-Agreement States) or the applicable Agreement State agency's regulatory authority. To help ensure that hazardous constituents stay within the production zone aquifer in the ISR wellfield and that groundwater quality is restored following ISR operations, the NRC or Agreement State agency regulates the construction and operation of wells associated with ISR production, groundwater monitoring, and groundwater restoration in ISR wellfields.

Table 1 identifies ISR facilities currently regulated by the NRC and the Agreement States.

Table 1: ISR Facilities

Parent Company	ISR Facility (Location)	Regulated by	Small Business?
Cameco Resources	• Crow Butte (Nebraska)	NRC	No
	• Smith Ranch-Highland (Wyoming)[a]	Agreement State	
Energy Fuels	• Alta Mesa (Texas) • Nichols Ranch (Wyoming)[a]	Agreement State	Yes
Uranium One/Rosatom	• Willow Creek (Wyoming) • Moore Ranch (Wyoming)	Agreement State	No
Uranium Energy Corp.	• Hobson-La Palangana (Texas) • Burke Hollow (Texas) • Goliad (Texas) • Reno Creek (Wyoming)	Agreement State	Yes
Ur-Energy Inc.	• Lost Creek (Wyoming)[a]	Agreement State	Yes
Uranium Resources, Inc.	• Crownpoint (New Mexico) • Vasquez (Texas) • Kingsville Dome (Texas)	NRC and Agreement State	Yes
Azarga Uranium Corporation	• Dewey Burdock (South Dakota)	NRC	Yes
Peninsula Energy	• Ross (Wyoming)[a]	Agreement State	Yes

[a] During the first quarter of 2019, U.S. uranium was produced at these four U.S. uranium facilities, two fewer than in the fourth quarter of 2018.[1]

[1] U.S. Energy Information Administration, "Domestic Uranium Production Report 1st Quarter 2019," May 2019. Accessible at https://www.eia.gov/uranium/production/quarterly/pdf/qupd.pdf.