

Uranium-Loaded Water Treatment Resins: “Equivalent Feed” at NRC and Agreement State-Licensed Uranium Recovery Facilities – 12094

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ABSTRACT

Community Water Systems (CWSs) are required to remove uranium from drinking water to meet EPA standards. Similarly, mining operations are required to remove uranium from their dewatering discharges to meet permitted surface water discharge limits. Ion exchange (IX) is the primary treatment strategy used by these operations, which loads uranium onto resin beads. Presently, uranium-loaded resin from CWSs and mining operations can be disposed as a waste product or processed by NRC- or Agreement State-licensed uranium recovery facilities if that licensed facility has applied for and received permission to process “alternate feed.” The disposal of uranium-loaded resin is costly and the cost to amend a uranium recovery license to accept alternate feed can be a strong disincentive to commercial uranium recovery facilities. In response to this issue, the NRC issued a Regulatory Issue Summary (RIS) to clarify the agency’s policy that uranium-loaded resin from CWSs and mining operations can be processed by NRC- or Agreement State-licensed uranium recovery facilities without the need for an alternate feed license amendment when these resins are essentially the same, chemically and physically, to resins that licensed uranium recovery facilities currently use (i.e., equivalent feed).

INTRODUCTION

In December 2003, the U.S. Environmental Protection Agency (EPA) enacted a drinking water limit of 30 µg/L of uranium in drinking water [1]. This limit applied to Community Water Systems (CWSs), which the EPA defines as public water systems that supply water to the same population year-round. For very small to small CWSs (serving 25 – 3,300 people) that are required to remove uranium from drinking water to meet EPA standards, the transport, treatment, and disposal of treatment residuals (e.g., uranium loaded ion exchange (IX) treatment resin) can be a significant cost. The EPA currently defines uranium-loaded IX resin generated by drinking water treatment to remove the uranium as a Technically-Enhanced Naturally-Occurring Radioactive Material (TENORM) that requires disposal at a facility permitted under Subtitle C or D of the Resource Conservation & Recovery Act (RCRA). The EPA estimates that approximately 260,000 metric tons (MT) of TENORM wastes are generated each year by U.S. water treatment facilities. Eighty-three percent of the contaminated waste is filter sludge and the remaining 17 percent is ion exchange resins and charcoal [2].

As uranium continues to concentrate on IX resins, CWSs will eventually need a U.S. Nuclear Regulatory Commission (NRC) license to store and possess source material (e.g., uranium-loaded IX resin). According to regulations, an NRC license for source material is required when source material quantities are greater than or equal to 0.05% by weight (10 CFR 40.13(a)). If a CWS stores or possesses less than 15 pounds at any given time and less than 150 pounds per year, it is covered by a general license in 10 CFR 40.22(a). Otherwise, a specific license to store and possess the source material is required.

In April 2010 [3], EPA solicited comments as part of its review of national primary drinking water regulations (NPDWRs) for non-radon radionuclides (including uranium). This part of the NPDWRs, known as the Radionuclides Rule, was reviewed pursuant to Section 610 of the

Regulatory Flexibility Act to determine whether it should remain without change, or should be rescinded or be amended to minimize adverse economic impacts on small entities.

Commenters focused on several topics including the difficulties of handling and disposing of treatment waste streams. It is acknowledged by EPA that out of 51,988 CWSs [4], less than 1,000 will have to install treatment systems to address elevated non-radon radionuclides (see Figure 1 for the estimated number of systems related to treatment for uranium) [5]. Of this number, 98% of the systems serve less than 10,000 people. For these small-scale CWSs, handling of treatment residuals, such as uranium-loaded IX resin may account for 40 to 50 percent of their total operating budget. In response, EPA developed several guidance documents to help CWSs comply with the Radionuclide Rule while minimizing the economic impact of handling and disposing of the treatment waste streams. This guidance included the development of software to estimate quantities and concentrations of radionuclides in water treatment plant residuals, to assist CWSs in keeping the generation of treatment waste streams at a minimum [6]. Nevertheless, the financial burden of waste disposal led some stakeholders to urge EPA to reconsider its regulations related to uranium in drinking water, including the waste disposal requirements for such materials [7]. After reviewing all the comments regarding this Section 610 review, EPA concluded that revisions or amendments to the Radionuclides Rule were not warranted.

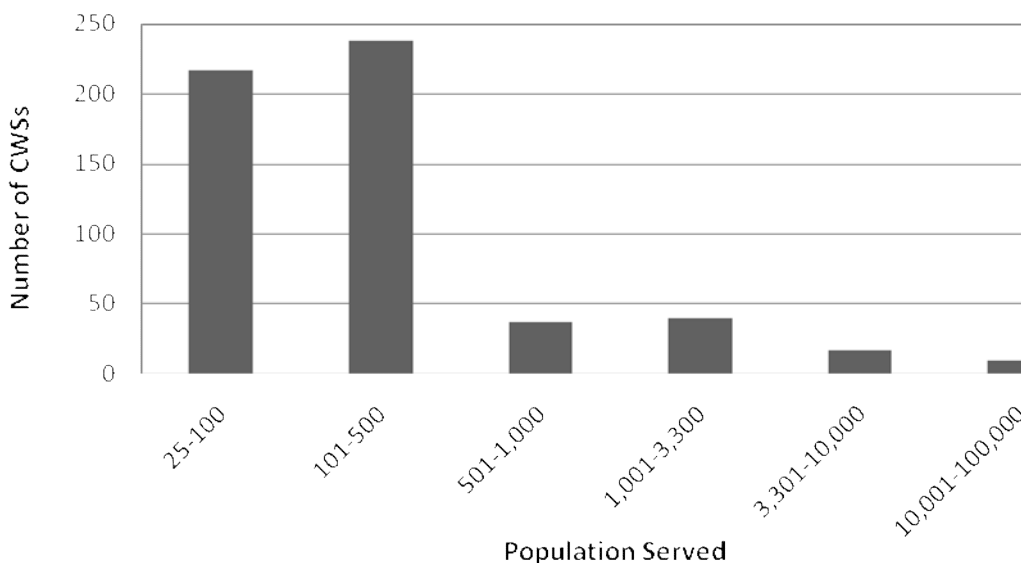


Figure 1. Number of CWSs Affected by the Radionuclides Rule for Uranium [5].

In addition to CWSs, mine dewatering operations could also generate uranium-loaded IX resin. Mine dewatering operations involve the extraction of water from surface or underground mines and, when necessary, the treatment of extracted water to remove pollutants prior to discharge. Mine dewatering is often necessary to allow miners to safely extract ore. In the case of uranium mine dewatering, extracted water is often treated by IX to remove uranium prior to discharge. These IX resins must either be disposed in a landfill or could be eluted at a uranium recovery facility. In the past, mine dewatering resins have been treated as alternate feed at conventional mills [8]. Those license amendments were required because, at that time, the staff considered

the mine dewatering resins to be processed or refined ore distinct from natural ore normally processed at a conventional mill.

URANIUM-LOADED IX RESIN PROCESSING

In addition to disposal at RCRA Subtitle C or D disposal facilities, CWSs or mine dewatering operations could arrange to send their uranium-loaded IX resin to a uranium recovery facility for processing. Uranium recovery facilities, which are licensed by the NRC or an NRC Agreement State, are uniquely positioned to process these resins. For example, in the uranium in-situ recovery process, injection wells inject a chemical solution (i.e., lixiviant) — typically sodium bicarbonate and oxygen — into a subsurface uranium ore body. The lixiviant dissolves the uranium from the ore body, which is collected in a series of recovery wells, which pump the pregnant lixiviant to a processing plant containing IX resins designed specifically to remove the uranium from the solution. Additional processing removes the uranium from the IX resin, with further purification, concentration, and drying producing the uranium fuel cycle commodity “yellowcake.” Conventional mills may also have existing IX processing circuits, either as part of its conventional milling process or a separate process line. Under these circumstances, conventional mills could also accept uranium-loaded IX resins.

Under past interpretations of NRC regulatory guidance, the processing of any uranium containing material not related to the milling process was considered the processing of “alternate feed”. In SECY-99-012 [9], NRC staff defined alternate feed as material other than natural uranium ores. Alternate feed can, therefore, be certain wastes, including sludges or soils, from other sites that contains recoverable amounts of uranium. Under this interpretation, a license amendment would be required for an NRC-licensed uranium recovery facility to accept uranium-bearing IX resins resulting from treatment of community water supplies or mine dewatering. Further guidance on evaluating requests for a license amendment for a uranium recovery facility to accept an alternate feed, recover the uranium, and dispose of the waste material as byproduct material in the mill tailings impoundment was provided in Regulatory Information Summary (RIS) 00-23 [10]. In RIS 00-23, NRC revised the manner in which NRC staff determined whether the alternate feed was being processed primarily for its source material content, focusing rather on the product of the processing and eliminating any inquiry into the licensee’s economic motives for the alternate feed processing. The net result of that interpretation meant a uranium recovery facility would need to undertake a time-consuming and relatively expensive licensing process prior to accepting any uranium-loaded IX resin from a CWS or mine dewatering operation.

EQUIVALENT FEED

NRC staff has determined that the interpretation discussed above does not reflect present day operating practices in the uranium recovery industry and is not consistent with the Commission’s intent in issuing RIS 00-23. Rather, NRC staff has determined that NRC and Agreement State-licensed uranium recovery facilities should be permitted to accept these IX resins as an “equivalent feed” without the need for a license amendment as long as the receiving facility can demonstrate that processing the equivalent feed stays within the facilities’ existing safety and environmental review envelope. Equivalent feed is defined as IX resin that is loaded with uranium at a facility other than a licensed uranium recovery facility, such as water treatment plants or mine dewatering operations.

The basis for NRC staff’s position relates to the original intent of RIS 00-23. RIS 00-23 and the underlying Commission decision was intended to address a concern that without restrictions on

the processing of material other than natural ore, a conventional uranium recovery mill could process any material containing uranium and dispose the waste in the tailings pile” resulting in what was then-termed “sham-disposal” [10] (i.e. waste material that would otherwise have to be disposed of as radioactive or mixed waste would be proposed for processing at a uranium mill primarily to be able to dispose that material in the tailings pile as 11e.(2) byproduct material). Thus, material very dissimilar to the material normally processed at a conventional mill, would be processed largely to allow disposal as 11e(2) byproduct material. In the case of uranium-loaded IX resin, the concern addressed in RIS 00-23 is not at issue. Uranium-loaded IX resin from CWSs and mine dewatering operations are essentially the same as resins used to extract uranium at an in-situ recovery facility and the resulting processing and waste products would be the same as those associated with normal in-situ uranium recovery operations. Also similar to in-situ recovery IX resin, uranium-loaded IX resin from CWSs and mine dewatering operations is designed to only capture uranium and not other hazardous constituents.

To constitute equivalent feed, resin must be “essentially the same” as IX resin that is currently used at licensed uranium recovery facilities and must not result in additional waste streams or risks not assessed during the licensing of the receiving uranium recovery facility. This “essentially the same” determination relates to both the chemical and physical properties of the IX resin. For example, a typical uranium treatment resin for drinking water (Z-92® also known as Lewatit GW 66®) is produced by Lanxess (aka Sybron Chemicals) [11,12]. The GW 66® resin is essentially the same in composition and function to the Dow 21K® resin [13], with is the typical IX resin used at most uranium recovery facilities. Table 1 contains a summary comparison of product information for the Lewatit GW 66® and Dow 21K® resins.

Table 1. Comparison of Lewatit GW 66® and Dow 21K® resins [11, 12, 13]

Physical and Chemical Property	Lewatit GW 66®	DOWEX 21K®
Resin Type	Type 1 strong base anion	Type 1 strong base anion
Material/Matrix	Divinylbenzene (DVB-styrene)	Divinylbenzene (DVB-styrene)
Functional Group	Quaternary amine	Quaternary amine
Ionic Form	Cl ⁻	Cl ⁻
Specific Gravity	1.08	1.08
Bulk Density	640 – 700 g/L	690 g/L
Total Exchange Capacity	1.3 eq.L	1.2 eq/L
Max Operating Temperature	158°F	212°F
Operating pH range	0 - 12	0 - 14

The product information indicates the following:

- Both are a strong-base, Type I anion exchange resin;
- The composition of both is divinylbenzene (dvb) styrene;
- The functional group of both is a quarternary amine;
- The physical form of both is resin beads with essentially the same bulk weight, color, and amine odor;
- GW 66® resin is available in a similar bead-size range to that of Dow 21K®;
- The Lanxess product information identifies the GW 66 resin as selective for uranium, nitrates, and sulfates; the Dow 21K resin is selective for uranium.

The primary difference between the GW 66® and the typical uranium recovery IX resin is that the water treatment resin is marked and packaged specifically for use in potable water systems and, therefore, undergoes an additional step of the Water Quality Association testing for certification to ANSI/NSF Standard 61.

Given that uranium-loaded IX resins are “essentially the same” as those resins processed at an in-situ recovery central processing plant, NRC staff sees no basis for requiring that uranium recovery facility operators obtain a license amendment to process this essentially same material. The same process is also used for eluting or recovering uranium from water treatment and in-situ recovery resins. Therefore, NRC staff determined that water treatment resins should be defined as “equivalent feed.” Thus, the processing of equivalent feed at a licensed uranium recovery facility will not require an amendment to an existing license as long as the existing limits on production of uranium in the license are not exceeded and that the processing is within the existing safety and environmental reviews.

For example, upon NRC staff inquiry, Kennecott Uranium Company (Kennecott) stated that it used IX resin to treat mine dewatering discharge near its Sweetwater County, Wyoming, mill. Kennecott uses the Dow 21K® resin that is discussed above; this resin is the same resin used at in-situ recovery facilities. Under the alternate feed policy, a uranium recovery facility would need a license amendment to process this resin. However, the staff is now determining that the IX resin is equivalent feed. Consequently, a uranium recovery facility can now process this resin, if the processing lines are previously licensed and production limits are not exceeded.

After processing the equivalent feed, the spent resin can be disposed as byproduct material in the same manner as the resin used in the primary uranium recovery activity. Disposal sites could either be existing mill tailings impoundments or other disposal facilities licensed by NRC or Agreement States. No additional disposal requirements are necessary. This approach benefits our national interest by recovering a valuable resource and benefits the environment by providing additional options instead of disposal for this material. Alternately, the unloaded resin may be returned to the water treatment facility, a mine dewatering facility, or a licensed uranium recovery facility for reuse. This is an economic benefit to the treatment facility (particularly CWSs) because operating costs are reduced and this results in less overall disposal of resin.

PROCESSING OF EQUIVALENT FEED: ADDITIONAL INFORMATION

Processing of equivalent feed from water treatment plants and mine dewatering operations at uranium recovery facilities (e.g. in-situ recovery or conventional mills/heap leach facilities with ion exchange circuits) results in a lower overall environmental impact and is the preferred option when compared to disposal of these resins in a RCRA-permitted landfill, or NRC- or Agreement State-licensed disposal facility. Transportation impacts are similar because in either option, the resin is trucked to an isolated location away from population centers (RCRA-permitted or NRC- Agreement State-licensed landfill or uranium recovery facility). Although disposal of equivalent feed in a lined RCRA-permitted landfill, or NRC- or Agreement State-licensed landfill provides short term isolation, the long-term environmental and financial liability associated with potential landfill failure coupled with the societal benefit of putting the uranium into the nuclear fuel cycle makes processing equivalent feed at a uranium recovery facility the preferred environmental option.

Processing water treatment resins as equivalent feed provides a significant cost benefit to CWSs. For those small water treatment operators, disposal at RCRA-permitted or NRC- or Agreement State-licensed landfills is cost prohibitive. At this time, it is not possible to know the

exact financial arrangements between the water treatment and uranium recovery facilities with respect to the processing of equivalent feed; however, it is reasonable to assume that the financial arrangements would be significantly more beneficial to small water treatment operators.

PROCEDURES FOR ACCEPTING EQUIVALENT FEED

Uranium recovery facilities with IX circuits may accept equivalent feed, as defined in this RIS, without a license amendment. The licensee should document that the received resins meet the equivalent feed criteria by being: (1) chemically and physically essentially the same as the resins processed at the facility; (2) processed the same way as resins processed at the facility; and (3) processing the equivalent feed material stays within the existing safety and environmental review for the facility. NRC inspectors will review this documentation during the inspection process to verify that the received resins meet the equivalent feed criteria, such that the licensee's processing of the material can be considered consistent with their license.

Following elution of the uranium-loaded equivalent feed (i.e., removal of the uranium from the treatment resin), the resulting unloaded resin can take two paths. Since the NRC is allowing equivalent feed to be processed at uranium recovery facilities, the wastes associated with processing equivalent feed (i.e., unloaded resin) are considered byproduct material, as defined in 10 CFR Part 40. Therefore, those wastes may be disposed of at an NRC-licensed facility. Alternately, the unloaded resin may be returned to a water treatment facility, a mine dewatering facility, or a licensed uranium recovery facility for reuse.

CONCLUSION

NRC staff is clarifying its current alternate feed policy to declare IX resins as equivalent feed. This clarification is necessary to alleviate a regulatory and financial burden on facilities that filter uranium using IX resin, such as CWSs and mine dewatering operations. Disposing of those resins in a licensed facility could be 40 to 50 percent of the total operations and maintenance (O&M) cost for a CWS. Allowing uranium recovery facilities to treat these resins without requiring a license amendment lowers O&M costs and captures a valuable natural resource.

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