Pacific Northwest NATIONAL LABORATORY

PNNL-28718

ILM-RPT-004

Direct Feed Low-Activity Waste Physical Property and Analyte Measurement Reduction

Recommendations for Measurement Removal

May 2019

CE Lonergan

U.S. DEPARTMENT OF ENERGY

Prepared for the U.S. Department of Energy under Contract DE-AC05-76RL01830

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Abstract

Processing of low-activity waste feed will occur at the Hanford Tank Waste Treatment and Immobilization Plant (WTP). In support of plant operations, and per requirements of the WTP contract, feed sample analyses will occur at least 18,000 times per year, generating over 7,000 liters of waste. The analytical measurements are often complicated by issues such as lack of standards, low concentrations, and difficult separations. Previous work has been completed to suggest removal of physical property and elemental analyses from required measurements, and this document summarizes that work.

Summary

Various requirements for property and elemental/isotopic analyses have been established to support the operation of the Hanford Tank Waste Treatment and Immobilization Plant (WTP). These analyses will ensure regulatory and reporting compliance as well as continued safe operation during vitrification of the low-activity waste. This document summarizes recent work that assessed the requirements for measurement of physical properties and analytes to determine recommendations for removal of analyses.[1,2,3]

The results of the analyses are summarized in the table below, with many properties and analytes recommended for removal from waste feed qualification sampling requirements.

Table S1. Recommendations for properties, elements, and isotopes addressed in this summary

	Recommend: No Measurement	Recommend: Process Knowledge/Existing Correlations	Recommend: Measurement Required
Inorganic Analysis	Calcium; iron; lanthanum; total uranium	Shear strength; hydrogen generation rate; waste compatibility	Major species; RCRA (Resource Conservation and Recovery Act) metals; ammonium/ ammonia; pH; waste feed and supernate viscosity; density
Radionuclide Analysis^	Isotopes required for reporting only	Isotopes required for regulatory or operational requirements, with the exception of ^{137}Cs, ^{90}Sr, and ^{99}Tc	^{137}Cs, ^{90}Sr, and ^{99}Tc

[1] Lonergan C. 2019. *Recommendations for Reduction in Radionuclide Analyte Analysis in Support of WTP Operations*. PNNL-28423, Pacific Northwest National Laboratory, Richland, WA.
[2] Stone M. 2019. *Waste Acceptance Composition Requirements: Inorganic Species Evaluations.* SRNL-L3300-2019-00016, Rev. 0, Savannah River National Laboratory, Aiken, SC.
[3] Rieck B. 2018. *Constituents Important to ILAW Glass Formulation and Product Compliance Reporting*. 24590-LAW-POSP-PENG-17-00002, Rev. 1, Bechtel National, Inc., Richland, WA.

Acknowledgments

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Quality Assurance

This work was performed in accordance with the Pacific Northwest National Laboratory (PNNL) Nuclear Quality Assurance Program (NQAP). The NQAP complies with U.S. Department of Energy (DOE) Order 414.1D, *Quality Assurance*, and 10 CFR 830, Subpart A, "Quality Assurance Requirements." The NQAP uses NQA 1 2012, *Quality Assurance Requirements for Nuclear Facility Application*, as its consensus standard and NQA-1 2012, Subpart 4.2.1 as the basis for its graded approach to quality.

The NQAP works in conjunction with PNNL's laboratory-level Quality Management Program, which is based on the requirements as defined in DOE Order 414.1D, *Quality Assurance*, and 10 CFR 830, *Nuclear Safety Management*, Subpart A, "Quality Assurance Requirements." The information associated with this report was acquired under a "Basic Research" designation and should not be used as design input or operating parameters without additional qualification.

Acronyms and Abbreviations

BBI	best basis inventory
CFR	Code of Federal Regulations
DF	direct feed
DFLAW	direct feed low-activity waste
DOE	U.S. Department of Energy
DQO	*Integrated DFLAW Feed Qualification Data Quality Objectives*
ILAW	immobilized low-activity waste
LAW	low-activity waste
LAWPS	Low-Activity Waste Pretreatment System
NQAP	Nuclear Quality Assurance Program
ORP	Office of River Protection
PNNL	Pacific Northwest National Laboratory
RCRA	Resource Conservation and Recovery Act
RIE	Rapid Improvement Event
SRNL	Savannah River National Laboratory
TRU	transuranic isotopes (^{237}Np, ^{238}Pu, $^{239/240}Pu$, ^{242}Pu, ^{241}Am, ^{243}Am, ^{242}Cm, $^{243/244}Cm$)
TUA	Tank Utilization Assessment
WAC	waste acceptance criteria
WTP	Hanford Tank Waste Treatment and Immobilization plant

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1.0 Introduction

Legacy tank waste at the Hanford Site will be processed through the Hanford Tank Waste Treatment and Immobilization Plant (WTP) according to the WTP contract (DOE 2000). The supernatant (soluble fraction) of the waste will be converted into low-activity waste (LAW) glass in the WTP. The process of retrieving the waste from the tanks, transferring it to the WTP, and then melting and pouring the final glass involves measurement of various physicochemical properties of the waste streams and concentrations of elements in the waste and subsequently prepared waste, plus added glass-forming chemicals (LAW feed) for various requirements.

The direct feed low-activity waste (DFLAW) process will include sampling and analysis of properties and elements for feed qualification, waste acceptance verification, process control, and regulatory compliance requirements. The requirements for acceptance measurements for physical properties, inorganic species, and radionuclide species are provided in the *Integrated DFLAW Feed Qualification Data Quality Objectives* (DQO; Nguyen 2018).

Recent work has been completed to provide data and analysis to support recommendations for potential removal of analytes that do not need analysis due to low concentrations, minimal requirements for reporting, or available process knowledge to suffice for associated requirements (Lonergan 2019; Stone 2019; Rieck 2018). This report seeks to summarize those findings.

2.0 Regulations and Requirements

The DQO (Nguyen 2018) describes the need for waste feed acceptance and adherence to qualification requirements for the processing of waste in the WTP LAW facilities. The qualification provides data that are needed for regulatory reporting, feed acceptance, and contractual reporting. In addition to those needs, further in the future the following will need to be demonstrated: compliance with WTP contract requirements for the final product, product recipe development, product qualification testing, and more. A summary of analyses required for feed qualification is shown in Table 1.

Table 1. Analytes required for DFLAW feed qualification (Nguyen 2018)

Analytical Parameters	WTP WAC	WTP Regulatory Reporting	DF LAWPS WAC	DF LAWPS Regulatory Reporting	Contractual Reporting
pH	X	X			
Viscosity	X		X	X	
Shear strength and other non-Newtonian rheological properties			X		
Total suspended solids	X		X	X	
Density	X	X	X	X	
Hydrogen generation rate	X				
Waste compatibility	X	X			
Separable organics	X				
Na	X	X	X	X	X
K			X		X
Cl	X	X			X
F	X	X			X
PO_4			X	X	X
SO_4	X	X			X
Hg	X	X			X
Total organic carbon	X	X			X
NH_4	X	X			
Poly-chlorinated biphenyls	X	X			
^{137}Cs	X		X	X	X
^{154}Eu	X				X
^{60}Co	X				X
^{90}Sr	X				X
^{99}Tc	X				X

Analytical Parameters	WTP WAC	WTP Regulatory Reporting	DF LAWPS WAC	DF LAWPS Regulatory Reporting	Contractual Reporting
$^{239/240}Pu$	X				
Transuranics (^{237}Np, ^{238}Pu, $^{239/240}Pu$, ^{242}Pu, ^{241}Am, ^{243}Am, ^{242}Cm, $^{243/244}Cm$)	X				X
^{233}U	X				
^{235}U	X				
^{238}U	X				
As		X			
Ba		X			X
Cd		X			X
Cr		X			X
Pb		X			X
Se		X			
Ag		X			X
Cs			X	X	
Al					X
Sb		X			
Be		X			
Ni		X			X
Tl		X			
Ca					X
Fe					X
NO_2					X
NO_3					X
CO_3 (total inorganic carbon)					X
La					X
U (sum of ^{233}U, ^{235}U, and ^{238}U)					X

DF is direct feed; LAWPS is Low-Activity Waste Pretreatment System; WAC is waste acceptance criteria.

While there are requirements for reporting and regulatory compliance, there are also requirements related to analytes that are important for glass formulation. Rieck (2018) provides a summary of which documents define requirements for measurement of constituents that heavily impact glass formulation and production reporting. Summary tables from that report are provided below in Table 2 and Table 3.

Table 2. Requirements related to constituents important for glass formulations from Rieck (2018)

Requirement for Glass Formulation	Source
Al, B,[(a)] Ca, Cl, Cr, F, Fe, K, Li, Mg, Na, P, Si, S, Ti, Zn, Zr, and the "Sum of Minors"[(b)] are constrained for model validity.	24590-LAW-RPT-RT-04-0003, Table 11
The target ratio of moles of carbon to moles of nitrogen (C/N) is 0.75. This is to control the redox chemistry in the melter. Sources of carbon are total organic carbon from waste and sucrose added to melter feed batches. Sources of nitrogen are nitrate and nitrite from waste.	24590-LAW-RPT-RT-04-0003, Section 5.1.5 (page 63)
Requirements for wt% loading of waste Na2O	Contract Specification 2.2.2.2
Class C limits for ^{14}C, ^{63}Ni, ^{90}Sr, ^{99}Tc, ^{129}I, ^{137}Cs, ^{241}Pu, ^{242}Cm, and TRU[(c)]	Contract Specification 2.2.2.7, 10 CFR 61.55
Limits for ^{137}Cs (< 3 Ci/m³) and ^{90}Sr (< 20 Ci/m³) in immobilized low-activity waste (ILAW) product	Contract Specification 2.2.2.8
^{137}Cs < 0.3 Ci/m^3 for ILAW melter maintenance	Contract Section C.7(d)(1)(iii)

(a) While boron (B) is not listed for LAW 1a in 24590-WTP-PL-PR-04-0001, *Integrated Sampling and Analysis Requirements Document (ISARD)*, it is required for glass formulation. Bismuth (Bi) was inadvertently listed under LAW 1a in place of B in the ISARD as a typo, and is also listed in the *Integrated Sampling and Analysis Plan (ISAP)* (Arakali and Johnston 2013) under the LAW 1a sample point. However, there is no basis for measuring Bi to support glass formulation, because it is a minor constituent in the LAW feed.

(b) The sum of minors is the sum of all constituents in the final glass composition that are not individually listed as having a single component model validity constraint in Table 11 of the source document. The upper limit for this quantity is 0.28 wt%, which falls below the > 0.5 wt% requirement for reporting per WTP Contract Specification 2.2.2.6.2.

(c) "TRU" signifies alpha emitting transuranic (TRU) isotopes with half-lives greater than 5 years per 10 CFR 61.55. The TRU isotopes present in Hanford tank waste that fit this definition are ^{237}Np, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Am, ^{242}Pu, ^{243}Am, ^{243}Cm, and ^{244}Cm. These are hereafter collectively referred to as "TRU." The presence of additional curium isotopes (i.e., ^{245}Cm, ^{246}Cm, ^{247}Cm, ^{248}Cm, ^{250}Cm) that fit this definition is too low to be measured due to lack of significant production per 24590-WTP-RPT-RT-02-004, *WTP Data Specification Process*.

Table 3. Requirements related to ILAW production reporting from Rieck (2018)

Requirement for ILAW Compliance Reporting	Source(s)
Reported chemical composition of glass shall include elements (excluding oxygen) present in concentrations > 0.5 wt% and elements and compounds required to meet regulatory or contract requirements.	Contract Specification 2.2.2.6.2
Radionuclides that are "significant" shall be reported in the ILAW composition. Significant radionuclides satisfy at least one of the following conditions: • For those radionuclides listed in Tables 1 and 2 of 10 CFR 61.55, if their activities exceed 0.01 times the lowest limit listed in either of the tables. • For those not listed in 10 CFR 61.55, if their activity in the container exceeds > 7 Ci/m³ (0.26 MBq/cm³) in glass. • For all radionuclides, if their overall activity in the ILAW container is greater than 1% of the total activity in the ILAW container (units of Ci). • For ^{99}Tc, if the concentration exceeds 0.003 Ci/m³.	Contract Specification 2.2.2.7, 10 CFR 61.55, NUREG/BR-0204 (Rev. 2, page 20), 49 CFR 172.101
Surface dose rate limit (500 mrem/hr). No specific radionuclides that may contribute to surface dose rate are listed in the WTP contract. However, the calculation 24590-WTP-Z0CW13T-00019, *Dose Rate Equations for LAW Containers and HLW Canisters*, lists ^{137}Cs, ^{60}Co, ^{154}Eu, and ^{90}Sr as being the only significant contributors to the surface dose rate. The ILAW algorithm does not perform surface dose rate calculations. The compliance strategy in the ILAW Project Control Plan is to perform engineering analyses during qualification and perform surface dose rate measurements during production after ILAW containers are lidded and decontaminated. The latest available projections suggest that ILAW containers will be below the limit (24590-LAW-Z0C-W13T-00002, *LAW Facility Bulk Shielding Confirmation*).	Contract Specification 2.2.2.9

These requirements, as specified in various documents, especially the WTP contract (DOE 2000), drive what measurements are needed. Section 3.0 summarizes the results of recent work to understand the requirements and what samplings are not necessary to fulfilling the established requirements.

3.0 Results of Measurement Evaluations

Documents were prepared to describe the current requirements for physicochemical property and elemental/isotopic concentration measurements, including several reports referenced in this document (i.e., Lonergan 2019; Stone 2019; Rieck 2018; Arakali and Johnston 2013). The documents provided data and recommendations for removal of properties or analytes to allow for decreased samplings, resources for measurements, resulting waste, and less time at hold points during waste processing. As mentioned by Stone (2019), “It should be noted that the DQO reduced the organic analytes specified based on the expected draft of an updated Human Health and Environment Risk Assessment performed by Hanford Waste Treatment and Immobilization Plant (WTP) (also still in draft status).”

3.1 Inorganic Species Evaluations

Stone (2019) discusses requirements for waste acceptance with regards to inorganic species and physical properties of DFLAW feed. Support for the recommendations in the document come from the 2018 DQO (Nguyen 2018) and a Rapid Improvement Event (RIE) completed by Washington River Protection Solutions, Inc. The recommendations from the RIE that impact number of measurements were discussed in previous documents (i.e., Stone 2019; Stone et al. 2016) and will only be summarized here as reported by Stone (2019).

1) *“Ensure integrated DFLAW WFG plan has description of what to do when process knowledge is close to limit. WFG plan defines when process knowledge is used.”*
2) *“Use simulants and models to eliminate sample analysis: Viscosity proof of Newtonian and melter feed rheology”*
3) *“Use process knowledge for C-14, tritium, total Cs, and separable organics.”*
4) *“Evaluate risk assessment results and eliminate CN if acceptable. Evaluate DFLAW tanks coming from FeCN and utilize process knowledge.”*
5) *“Eliminate HGR measurement from DFLAW. Use existing correlation, review history, and make technical case.”*
6) *“Use process knowledge for waste compatibility analysis. Use historical data. May need modification of WTP dangerous waste permit.”*
7) *“Use simulants and models after model is proven to drop the laboratory analysis for precipitation temperature.”*

Table 4 summarizes the conclusions from analysis of efforts to reduce inorganic analyte and physical property measurement. It describes which properties or parameters are recommended to be measured, which could be reported using previous correlations or process knowledge, and which may be eliminated as informed by the DQO and RIE.

Table 4. Recommendations for measurement of physical properties and inorganic species

Status of the Analytes/Properties of Interest	Properties/Analytes of Interest
Measurement needed	Major species[(a)] (sodium, nitrate, hydroxide, aluminum, nitrite, carbonate, phosphate, sulfate, chromium, fluoride, oxalate, chloride, potassium, fluoride, total organic carbon liquid, silicon); RCRA[(b)] metals (silver, arsenic, barium, beryllium, cadmium, chromium, mercury, nickel, lead, antimony, selenium, thallium); ammonium/ammonia; pH; waste feed and supernate viscosity; density; total cesium
Process knowledge/ existing correlations acceptable	Shear strength; hydrogen generation rate[(c)]; waste compatibility
No measurement needed	Minor species[(a)] (calcium, iron, lanthanum); total uranium[(d)]

(a) Defined in Stone (2019) and measured for waste feed qualification.
(b) Resource Conservation and Recovery Act.
(c) Measurement suggested if calculated generation rate value is “at least 20% of the action limit” (Stone 2019).
(d) Determined relative to the corresponding isotope(s); uranium may require measurement if one or more isotopes are eliminated from measurement.

3.2 Radionuclide Isotope Evaluations

Previous work has been done to assess which radionuclide isotopes may be eliminated from required measurements (Lonergan 2019; Rieck 2018). Table 3 summarizes the documents that establish many of the requirements for radionuclide analysis that are referenced in the WTP contract (DOE 2000). Note that the WTP contract requires measurement of a few radionuclides: ^{99}Tc, ^{137}Cs, and ^{90}Sr (further described in Table 3), and this document does not seek to change that requirement.

Many radionuclides are only required for reporting (Table 1), and it is recommended that process knowledge be used for the concentrations needed in associated documentation for the ILAW product. As mentioned above, a few analytes (^{99}Tc, ^{137}Cs, and ^{90}Sr) will be measured regardless of anticipated concentration and that is likely to remain unchanged. Concentrations of other analytes, such as ^{129}I and ^{241}Pu, that are necessary to know for regulatory reporting may be assessed using process knowledge and decisions may be made after calculations are performed with batch feed estimates. Examples of how that can be done are provided below.

An analysis of the batch feed estimates from the Tank Utilization Assessment (TUA) of 2013 (Jenkins et al. 2013) was completed to provide a basis for recommendations for radionuclide measurement removal. The number of batches where a given isotope exceeded either the reporting threshold or the processing limits for the requirements mentioned above [i.e., WTP contract (DOE 2000), NUREG/BR-0204 (NRC 1998), and 49 CFR 172.101] was provided for 44 isotopes out of 746 batches for the full Hanford mission and 386 batches for DFLAW. Additionally, concentrations for all isotopes in the batch feed estimates relative to their respective reporting thresholds or limits were shown for the full Hanford mission, which covers DFLAW for the first 10 years.

Table 5 summarizes the results of analysis for the number of batches where the concentration of the specified isotope exceeded the corresponding value during DFLAW processing. ^{137}Cs is not included below as it is required to be measured as specified above. The concentration of ^{137}Cs exceeded the 49 CFR 172.101 reporting threshold for 99% of the batches but did not exceed the WTP contract limit (0.3 Ci/m^3) for any batches. ^{137m}Ba did not have a reporting threshold established by 49 CFR 172.101, so is not reported in that portion of the table.

Table 5. Summary of the percentages of batches for each isotope that exceeded set thresholds or limits according to TUA2013 batch estimates for DFLAW processing. (Values in parenthesis indicate the percentage of batches where the isotope exceeds the value for significance or reporting.)

% of Batches Exceeding Limits or Significance Values	WTP Contract and NUREG/BR-0204	49 CFR 172.101
< 1%	^{106}Ru, ^{113}Cd, ^{125}Sb, ^{126}Sn, ^{129}I, ^{134}Cs, ^{137m}Ba, $^{152/154/155}Eu$, $^{226/228}Ra$, ^{227}Ac, $^{229/232}Th$, ^{231}Pa, $^{232/233/234/235/236/238}U$, ^{237}Np, $^{238/241/242}Pu$, $^{242/243/244}Cm$, ^{243}Am, ^{59}Ni, ^{60}Co, ^{79}Se, ^{93}Zr, ^{93m}Nb	^{106}Ru, ^{125}Sb, ^{134}Cs, $^{152/154/155}Eu$, $^{226/228}Ra$, ^{229}Th, $^{232/233/234/235/236/238}U$, $^{242/243}Cm$, ^{242}Pu, ^{59}Ni, ^{60}Co, ^{79}Se, ^{93m}Nb
1% - 5%	^{90}Sr (2%), ^{90}Y (4%)	^{231}Pa (4%), ^{63}Ni (2%)
5% - 50%	^{151}Sm (33%), ^{240}Pu (18%),	^{232}Th (12%), ^{241}Pu (50%), ^{243}Am (18%)
> 50%	^{239}Pu (94%), ^{99}Tc (100%), ^{241}Am (99%), ^{63}Ni (100%)	^{113}Cd (99%), ^{126}Sn (57%), ^{129}I (100%), ^{151}Sm (100%), ^{227}Ac (74%), ^{237}Np (97%), ^{238}Pu (98%), $^{239/240}Pu$ (100%), ^{241}Am (100%), ^{244}Cm (75%), ^{90}Sr (100%), ^{90}Y (100%), ^{93}Zr (91%), ^{99}Tc (99%)

The conservative cutoff for acceptable percentage of batches that exceed their thresholds, or have isotopic concentrations greater than the associated limit, was set at 1%.

In addition to the calculation of the number of batches where a given isotope exceeded its specified value, data were provided to show which batches exceeded the thresholds or limits for all radionuclides. An example plot is provided below (Figure 1) and shows the concentration of a given isotope divided by the defined value according to NUREG/BR-0204 as a function of batch number.

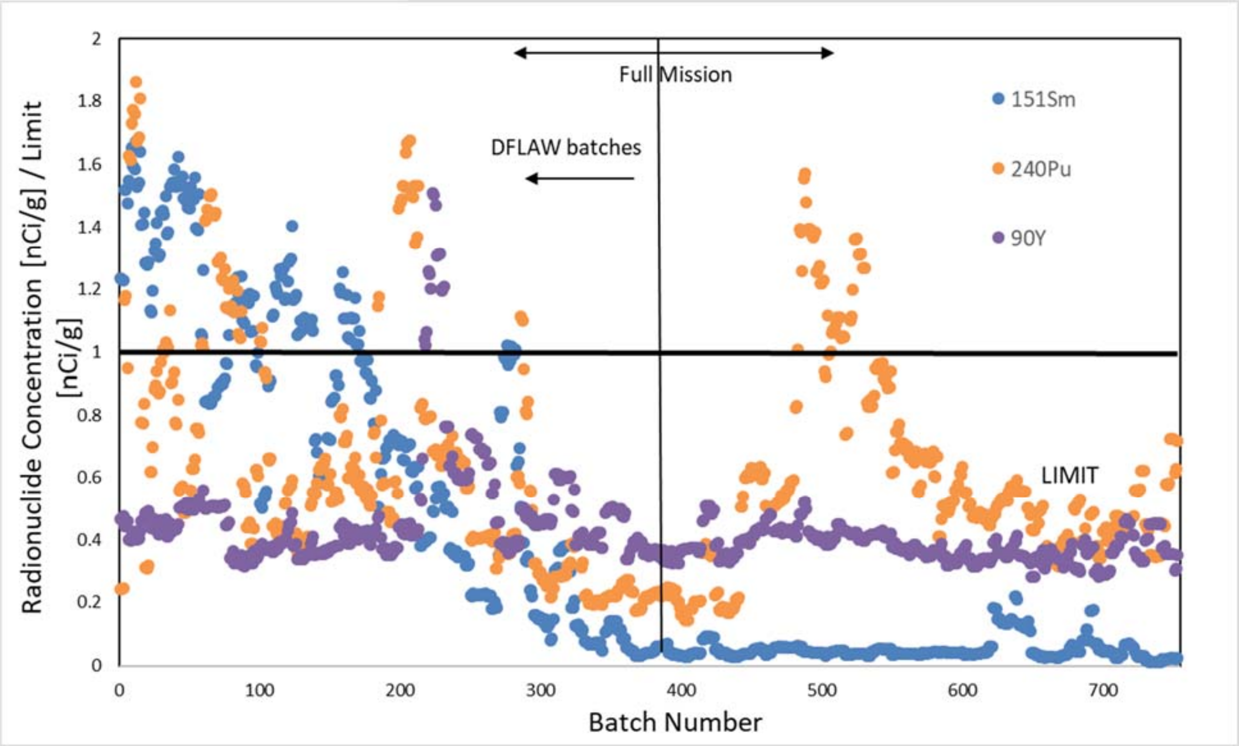

Figure 1. Radionuclide concentration fraction relative to its respective reporting significance value in NUREG/BR-0204 versus batch number (Lonergan 2019). The first 386 batches represent DFLAW.

Table 6 summarizes the maximum value fraction, i.e., concentration of isotope divided by its threshold or limit, for each isotope projected during the first 10 years. A value of 1 means the concentration of that isotope in a given batch is the same as the value defined in the regulating document.

Table 6. Ranges of the maximum fraction of limit for radionuclide analytes for NUREG/BR-0204 and 49 CFR 172.101

Maximum Value Fraction (=isotope concentration/ threshold or limit)	NUREG/BR-0204	49 CFR 172.101
<0.2	^{106}Ru, ^{113}Cd, ^{125}Sb, ^{126}Sn, ^{134}Cs, ^{137m}Ba, $^{152/154/155}$Eu, $^{226/228}$Ra, ^{227}Ac, $^{229/232}$Th, ^{231}Pa, $^{232/233/234/235/236/238}$U, $^{242/243}$Cm, ^{243}Am, ^{59}Ni, ^{60}Co, ^{79}Se, ^{93}Zr, ^{93m}Nb	^{106}Ru, ^{125}Sb, ^{134}Cs, $^{152/155}$Eu, $^{226/228}$Ra, ^{231}Pa, $^{232/235/236}$U, ^{242}Cm, ^{243}Am, ^{59}Ni, ^{60}Co, ^{93m}Nb
0.2 – 0.5	^{237}Np, ^{244}Cm	^{154}Eu, ^{238}U, ^{79}Se
0.5 – 1.0	^{129}I, ^{238}Pu, ^{241}Pu	^{229}Th, $^{233/234}$U, ^{243}Cm
>1.0	^{151}Sm, $^{239/240}$Pu, ^{241}Am, ^{63}Ni, ^{90}Sr, ^{90}Y, ^{99}Tc	^{113}Cd, ^{126}Sn, ^{129}I, ^{151}Sm, ^{227}Ac, ^{232}Pa, ^{232}Th, ^{237}Np, $^{238/239/240/241}$Pu, $^{241/243}$Am, ^{244}Cm, ^{63}Ni, ^{90}Sr, ^{90}Y, ^{93}Zr, ^{99}Tc

Maximum value fractions of 0.2 or less can be useful to consider as a buffer to allow minimal impacts from unknown uncertainties. For values that are not operational limits but are only required for reporting, process knowledge or databases such as the best basis inventory (BBI) could be used. The BBI, or similar, could also be applied for limits specified in Specification 2.2.2.8 of the WTP contract that concentrations of certain radionuclides, i.e., ^{129}I, ^{241}Pu, ^{242}Cm, and TRU, “shall not exceed Class C limits as defined in 10 CFR 61.55” (DOE 2000). The maximum value fractions of the analytes specified in 2.2.2.8 that possess from 0.2 to 0.5 and may also be considered if less conservatism is desired, as that range provides a two-fold allowance for uncertainty. Analytes with a maximum fraction limit of less than 0.2 for both limits are as follows: ^{106}Ru, ^{125}Sb, ^{134}Cs, $^{152/155}$Eu, $^{226/228}$Ra, ^{231}Pa, $^{232/235/236}$U, ^{242}Cm, ^{243}Am, ^{59}Ni, ^{60}Co, ^{93m}Nb. All of those analytes had less than 1% of the batches exceed their respective value during DFLAW processing, except for ^{231}Pa (4% batches exceeded threshold) and ^{243}Am (18% batches exceeded the threshold). It could be argued that all of the analytes listed above with fraction of limits less than 0.2 can be removed from required measurement. The removal of U isotopes from measurement may impact the need to measure total U.

Additionally, it was noted that NUREG/BR-0204 and 49 CFR 172.101 were generated by a governing body regulating commercial facilities and are mainly used to regulate the transport of hazardous materials. As the Hanford Site is a government entity, governed by the U.S. Department of Energy, and disposal will occur on site, i.e., no need for transport on public infrastructure, there is little reason for these regulations to dictate disposal for Hanford LAW forms. For maximum fraction of values greater than 0.2, the removal of one or both requirements will impact which isotopes would need to be measured or can be determined via process knowledge, if a buffer is required.

4.0 Summary

This document summarizes previous work that investigated the need for measurement of physical properties and radioactive/non-radioactive elements (i.e., Lonergan 2019; Stone 2019; Rieck 2018).

An assessment of analytes and properties and whether they are recommended for measurement during DFLAW processing was provided and the results are shown below.

Table 7. Recommendations for properties, elements, and isotopes addressed in this summary

Evaluation	No Measurement	Process Knowledge/Existing Correlations	Measurement Required
Inorganic and physicochemical property analysis	Calcium, iron, lanthanum; total uranium[(a)]	Shear strength; hydrogen generation rate; waste compatibility	Major species; RCRA[(b)] metals; ammonium/ ammonia; pH; waste feed and supernate viscosity; density, total cesium
Radionuclide analysis[(b)]	Isotopes required for reporting only	Isotopes required for regulatory or operational requirements, with the exception of ^{137}Cs, ^{90}Sr, and ^{99}Tc (i.e., ^{129}I and ^{241}Pu)	^{137}Cs, ^{90}Sr, and ^{99}Tc

(a) May require measurement if the U isotopes are no longer measured.
(b) Does not account for the removal of NUREG/BR-0204 and 49 CFR 172.101.

The summary for radionuclide analysis is based on what isotopes can be represented using process knowledge or what is required to be measured for operations. If process knowledge will be used, then approaches similar to those described above can be employed to determine which isotopes should be measured and which can be reported with previous data.

5.0 References

49 CFR 172.101. “Purpose and use of hazardous materials table.” U.S. Code of Federal Regulations.

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