U.S. Department
of Transportation

**Pipeline and Hazardous
Materials Safety
Administration**

1200 New Jersey Avenue, SE
Washington, DC 20590

AUG 2 1 2018

Janet Schlueter
Senior Director
Nuclear Energy Institute
1201 F Street NW, Suite 1100
Washington, DC 20004

Reference No. 18-0014

Dear Ms. Schlueter:

This letter is in response to your January 18, 2018, email requesting clarification of the Hazardous Materials Regulations (HMR; 49 CFR Parts 171-180) applicable to non-radioactive solid objects with surface radioactive contamination. Specifically, you ask about amendments made in the HM-250 Final Rule (79 FR 40590; July 11, 2014).

We have paraphrased and answered your questions as follows:

Q1. You ask if the threshold for low toxicity alpha emitters—0.4 Bq/cm^2—applies for uranium-234 (U-234) when determining levels of contamination.

A1. The answer is no. The definition of low toxicity alpha emitters includes natural uranium, depleted uranium, uranium-235, and uranium-238. It specifically excludes enriched uranium, including uranium-234. Therefore, the more stringent contamination limit for other alpha emitters would apply—0.04 Bq/cm^2.

Q2. You note that the HM-250 Final Rule added § 173.401(b)(5) to except non-radioactive solid objects with low levels of surface contamination from the HMR requirements for radioactive substances. You ask whether this amendment invalidates a letter of interpretation previously issued by this Office under Reference No. 06-0274.

A2. The answer is no. The addition of § 173.401(b)(5) excludes certain materials from the requirements of 49 CFR 173 Subpart I, in addition to the exemptions found in § 173.436. PHMSA addressed Reference No. 06-0274 in the HM-250 Final Rule, stating that § 173.401(b)(5) was added to clarify that non-radioactive solid objects with radioactive substances present on any surfaces in quantities not exceeding the limits cited in the definition of contamination in § 173.403 are not subject to the Class 7 (radioactive) material requirements of the HMR.

HM-250 also explains that radioactive contaminated items below the consignment exemption limits in § 173.436 are not regulated as radioactive materials. Thus, while uranium-234 may not be excepted from the HMR based on § 173.401(b)(5), it is possible that it would not be regulated as a radioactive material based on exempted material activity concentrations in § 173.436.

I hope this information is helpful. Please contact us if we can be of further assistance.

Sincerely,

Dirk Der Kinderen
Chief, Standards Development Branch
Standards and Rulemaking Division

Casey
§173.401(b)
RAM
18-0014

Dodd, Alice (PHMSA)

From:	Kelley, Shane (PHMSA)
Sent:	Thursday, January 25, 2018 9:07 AM
To:	Dodd, Alice (PHMSA); January, Ikeya CTR (PHMSA)
Cc:	DerKinderen, Dirk (PHMSA); Nickels, Matthew (PHMSA); Foster, Glenn (PHMSA)
Subject:	FW: Need for Official PHMSA Position on Selecting Appropriate Contamination Limits for Alpha Emitters
Attachments:	01-18-18_DOT_Contamination Limits for Alpha Emitters.pdf

Please log for response as an interp request. Thanks

From: Falat, Lad (PHMSA)
Sent: Tuesday, January 23, 2018 12:35:42 PM
To: Meidl, Rachel (PHMSA); Klinger, Patricia (PHMSA); Kelley, Shane (PHMSA); Tackett, Christina (PHMSA); Pfund, Duane (PHMSA)
Subject: FW: Need for Official PHMSA Position on Selecting Appropriate Contamination Limits for Alpha Emitters

FYI.
Shane, should we treat this as a interp request?
Lad

From: SCHLUETER, Janet [mailto:jrs@nei.org]
Sent: Thursday, January 18, 2018 5:18 PM
To: Falat, Lad (PHMSA) <lad.falat@dot.gov>
Cc: Boyle, Rick (PHMSA) <rick.boyle@dot.gov>; Williams, James (PHMSA) <James.Williams@dot.gov>
Subject: Need for Official PHMSA Position on Selecting Appropriate Contamination Limits for Alpha Emitters

THE ATTACHMENT CONTAINS THE COMPLETE CONTENTS OF THE LETTER

January 18, 2018

Mr. Lad Falat, Director
Division of Sciences, Engineering, and Research
Pipeline and Hazardous Materials Safety Administration
U.S. Department of Transportation
Washington, DC 20590

Subject: Need for Official PHMSA Position on Selecting Appropriate Contamination Limits for Alpha Emitters

Dear Mr. Falat,

On behalf of the Nuclear Energy Institute's (NEI) fuel cycle facility members (hereinafter referred to as industry), we would like to highlight the nuclear industry's commitment to adhering to the Department of Transportation (DOT) / Pipeline and Hazardous Materials Safety Administration (PHMSA) regulations as outlined in 49 Code of Federal

Regulations (CFR), not only from a regulatory compliance standpoint, but in ensuring the safety of the public and environment during transportation of radioactive materials on public roads.

If you have any questions about the content of this letter, please contact me, Hilary Lane (hml@nei.org, 202-739-8148) or Jerry Hiatt (jwh@nei.org, 202-739-8171) of my staff.

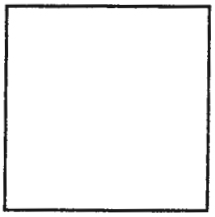
Sincerely,

Janet R. Schlueter
Senior Director
Radiation and Materials Safety

Nuclear Energy Institute
1201 F Street N.W., Suite 1100
Washington, DC 20004
www.nei.org

P: 202.739.8098
E: jrs@nei.org

c:
Rick Boyle, DOT/PHMSA
Jim Williams, DOT/PHMSA



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Sent through www.intermedia.com

JANET R. SCHLUETER
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NUCLEAR ENERGY INSTITUTE

January 18, 2018

Mr. Lad Falat, Director
Division of Sciences, Engineering, and Research
Pipeline and Hazardous Materials Safety Administration
U.S. Department of Transportation
Washington, DC 20590

Subject: Need for Official PHMSA Position on Selecting Appropriate Contamination Limits for Alpha Emitters

Dear Mr. Falat,

On behalf of the Nuclear Energy Institute's (NEI)[1] fuel cycle facility members (hereinafter referred to as industry), we would like to highlight the nuclear industry's commitment to adhering to the Department of Transportation (DOT) / Pipeline and Hazardous Materials Safety Administration (PHMSA) regulations as outlined in 49 Code of Federal Regulations (CFR), not only from a regulatory compliance standpoint, but in ensuring the safety of the public and environment during transportation of radioactive materials on public roads.

As industry does its due-diligence in evaluating their shipping programs and complying with DOT regulations, NEI was recently made aware of certain revisions to DOT regulations that are proving to be unnecessarily burdensome from a resource perspective with no added safety benefit. The purpose of this letter is to bring these issues to your attention, and to offer a proposed solution for mitigating the impact of this rule.

As you are aware, through a 2015 rulemaking, the scope of 49 CFR 173.401(b) was revised to add paragraph (5). 173.401(b)(5) states the subpart does not apply to:

"*Non-radioactive solid objects with radioactive substances present on any surfaces in quantities not exceeding the threshold limits set forth in the definition of contamination in 49 CFR 173.403.*"

[1] NEI is responsible for establishing unified nuclear industry policy on matters affecting the nuclear energy industry, including regulatory, financial, technical and legislative issues. NEI members include all companies licensed to operate commercial nuclear power plants in the United States, nuclear plant designers, major architect/engineering firms, fuel fabrication facilities, materials licensees, and other organizations and individuals involved in the nuclear energy industry.

Additionally, the definition of "contamination" in 49 CFR 173.403 ("Definitions") is outlined below:

"Contamination means the presence of a radioactive substance on a surface in quantities in excess of 0.4 Bq/cm^2 for beta and gamma emitters and low toxicity alpha emitters or 0.04 Bq/cm^2 for all other alpha emitters...."

The above referenced rulemaking change in 49 CFR 173.401(b) makes it critical to distinguish whether items contaminated with enriched uranium (or high enriched uranium) classify as a "low toxicity alpha emitter" or "all other alpha emitters" (i.e. high toxicity alpha emitter), particularly given the limit for "all other alpha" is more restrictive by a factor of 10 compared to the limit for "low toxicity alpha emitters." The definition of "low toxicity alpha emitter" as codified in 49 CFR 173.403 is outlined below:

"Low toxicity alpha emitters means natural uranium; depleted uranium; natural thorium; uranium-235 or uranium-238; thorium-232; thorium-228 and thorium-230 when contained in ores or physical and chemical concentrates; and alpha emitters with a half-life of less than 10 days."

This definition clearly excludes U-234 (the primary contributor to the total activity of enriched uranium) and enriched uranium from the "Low Toxicity" definition; therefore, based on industry's interpretation, the limit is not meant to be used for either U-234 or enriched uranium. The Nuclear Regulatory Commission's (NRC) definition of "low toxicity alpha emitters" in 10 CFR 71.4 is consistent with the DOT's definition, in that there is no mention of "enriched uranium" or uranium-234.

Other federal partners maintain that enriched uranium (and high enriched uranium) classify as "low toxicity alpha emitter" based on analysis using the NRC Regulatory Guide (RG) 8.21, Appendix B Table 1. In this table, U-234 is listed as a low toxicity alpha emitter. However, this does not align with industry's plain language interpretation of DOT's above referenced definition, which by deduction, classifies enriched uranium and high enriched uranium as a "high toxicity alpha emitter." While industry would like to gain alignment with their federal partner's interpretation, which would be favorable for all parties involved in such routine shipping transactions, industry must nevertheless abide by the DOT regulations for materials transported in commerce on public roads. Shipments conducted wholly by a government entity do not fall under the jurisdiction of the DOT.

This discrepancy of interpretation between stakeholders has had a disruptive effect on industry shipments and ongoing business operations. Using the "all other alpha emitters" threshold for defining contamination will undoubtedly cause an increase in Class 7 shipments of equipment from industry sites (when equipment is *not* being used as part of a conveyance[2] for a Class 7 shipment). Industry's selection of the appropriate toxicity limit is critical, in maintaining continuity of operations and ensuring that the hazards present for each shipment are properly communicated (markings, labels, placards, and paperwork) to protect human health and the environment.

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[2] A conveyance is a transport vehicle which includes all securement devices used for blocking and bracing, such as pallets, chains, and straps.

NEI understands that PHMSA issued a formal Letter of Interpretation on this matter in the past, referenced as 06-0274, which now appears invalidated by the 2015 rulemaking change referenced above. As you are aware, industry maintained substantial reliance on the prior Letter of Interpretation.

Industry Proposed Solution: *NEI requests confirmation from PHMSA on whether the previous Letter of Interpretation referenced above can still be applied. If this guidance no longer applies, NEI requests a new Letter of Interpretation (or other official response) that indicates: 1) the current PHMSA position, 2) additional clarity on whether the contamination limits for low toxicity alpha can be applied to materials contaminated with enriched uranium and high enrichment uranium and 3) other acceptable exemptions from the regulations as ably demonstrated in the previous Letter of Interpretation.*

Given the rulemaking changes, and inconsistent interpretations between industry and other federal entities, a validation of or issuance of a new Letter of Interpretation would be both timely and appropriate. With either option, we are requesting that an official response be expeditiously generated. Without a standing Letter of Interpretation from PHMSA, industry's current interpretation of the DOT regulations (which may be overly conservative) could be resulting in unjustified increased regulatory burden for surface contaminated materials in commerce. Amidst industry's broad day-to-day operating, business, and regulatory compliance responsibilities in an environment of increased regulation, we must strive to create an atmosphere that encourages and promotes regulatory clarity and efficiency. Addressing this uncertainty would be a prime example in fostering those aforementioned objectives. We look forward to your timely response on this important matter.

If you have any questions about the content of this letter, please contact me, Hilary Lane (hml@nei.org, 202-739-8148) or Jerry Hiatt (jwh@nei.org, 202-739-8171) of my staff.

Sincerely,

Janet R. Schlueter

c:
Rick Boyle, DOT/PHMSA
Jim Williams, DOT/PHMSA

Department of Energy
Washington, DC 20585

January 16, 2018

Mr. Rick Boyle
Chief, Radioactive Materials/ Research & Development (PHH-23)
Engineering and Research Division
Pipeline and Hazardous Materials Safety Administration
U.S. Department of Transportation
1200 New Jersey Ave. SE
Washington D.C. 20590-0001

Dear Rick Boyle:

The U.S. Department of Energy (DOE) requests the Department of Transportation (DOT) concurrence (or comment) with the enclosed, *Technical Basis for the Determination of the Toxicity of Highly Enriched Uranium at the Y-12 National Security Complex*, Document No. RCO/TBD-110, Rev 0, dated October 19, 2017. This document forms a technical basis for uranium-235 (enriched uranium), including the uranium-234 in uranium-235 (enriched uranium), being considered a low toxicity alpha emitter.

If you have any questions or need more details please call at 301-903-5513 or james.shuler@em.doe.gov.

James M. Shuler

Manager, DOE Packaging Certification Program
U.S. Department of Energy
Office of Packaging and Transportation
EM-4.24, 270CC – Rm 3113
Washington, DC 20585

Department of Energy
National Nuclear Security Administration
Production Office

P.O. Box 2050
Oak Ridge, Tennessee 37831

P.O. Box 30030
Amarillo, Texas 79120

National Nuclear Security Administration

January 12, 2018

MEMORANDUM FOR DR. JAMES SHULER
MANAGER, DOE PACKAGING AND CERTIFICATION
PROGRAM, EM-4.24

FROM: BECKY EDDY
NUCLEAR MATERIALS MANAGER
FOR PROGRAMS & PROJECTS

SUBJECT: Request for Assistance and Technical Basis for the Determination of the Toxicity of Highly Enriched Uranium at the Y-12 National Security Complex

Recently, there is some debate amongst hazardous material shippers if uranium-234 should be considered a high toxicity hazard or a low toxicity hazard. The radiological aspects (specific activity, dose coefficients, dosimetric models) of uranium-234 have been evaluated, and it has been determined that the Y-12 National Security Complex (Y-12 NSC) will continue to consider uranium-234 as a low toxicity hazard pending additional clarification from Department of Transportation (DOT) and based on supporting and scientific analysis. Therefore, I am writing to request your assistance to formally transmit to DOT the attached "Technical Basis for the Determination of the Toxicity of Highly Enriched Uranium at the Y-12 National Security Complex", Document No. RCO/TBD-110, Rev 0, dated October 19, 2017. This document forms a technical basis for uranium-235 (enriched uranium), including the uranium-234 in uranium-235 (enriched uranium), being considered a low toxicity alpha emitter.

The Y-12 NSC and other Department of Energy (DOE) uranium production facilities historically considered all enrichments of uranium to be low toxicity alpha emitters in regards to compliance with DOT regulations. The domestic and international nuclear fuel production community operate in a manner where uranium-235 and its small mass percentage of uranium-234 is treated as a low toxicity alpha emitter. However, regulatory definitions for low-toxicity alpha emitters are inconsistent amongst international and United States regulations, and 49CFR173.403 is somewhat ambiguous in regards to the toxicity of enriched uranium. To address the ambiguity, in 2011, the DOE, Oak Ridge Operations, Science Integrated Support Center, issued a complex-wide Packaging and Transportation Safety Regulatory Bulletin stating that enriched uranium is considered a low-toxicity alpha emitter.

Although DOE, International Atomic Energy Agency (IAEA), and Nuclear Regulatory Commission (NRC) regulations do not define uranium-234 as a low toxicity alpha emitter, neither do they define uranium-234 as a high toxicity emitter. It should be noted that one source of confusion for uranium-234 being omitted from the low-toxicity definition where uranium-235 is included, could be the result of implied definition of uranium-235 as enriched uranium in

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This document has been approved for release to the public by:
S.A. HAWKS 1/16/18
NPO-Y-12 Site Office Classification Officer Date

certain parts of the regulations, where uranium-234 is included as enriched uranium. For example, 49 CFR 173.403 (1)(i) – (1)(iii), Definitions - "Uranium - natural, depleted or enriched" provide an individual definition for natural, depleted and enriched, and 49 CFR 173.403 (2) states "In all cases listed in this definition, a very small mass percentage of uranium-234 is present." In some cases, reference to uranium-235 may imply enriched uranium, however it is not stated. This may be the case for the uranium-234 content in uranium-235 (enriched uranium) unspecified in the low toxicity alpha emitter definition.

Pending a DOT evaluation of enriched uranium as a low toxicity alpha emitter, the Y-12 NSC is making special accommodations to the company with a differing opinion for which I serve as the Contracting Officer's Representative. This has resulted in increased cost and schedule to Y-12 NSC operations; therefore, it has become very important to remove ambiguity in the regulations.

I respectfully request your assistance to consult with DOT on this matter and request that DOT consider the Y-12 NSC technical basis and other technical bases, along with consideration of how the DOE complex and domestic and foreign commercial uranium processors apply DOT, NRC and IAEA rules, and furthermore consult with DOE and other interested parties in the issuance of clarification based on appropriate technical and scientific analysis and identification of any impacts as applicable.

I look forward to working with you to resolve this matter. If you have any questions or require additional information, please contact me at (865) 576-4119 or becky.eddy@npo.doe.gov.

Attachment:
RCO/TBD-110, Rev. 0

cc w/attachment
M. Padilla, NPO-70
J. Armstrong, NPO-70
E. Hogan, NPO-70
S. Morris, NPO-60
M. Hitson, NPO-60
K. Kleinhans, CNS
Charlie Irons, CNS

RCO/TBD-110, Rev. 0

Consolidated Nuclear Security, LLC
Y-12 National Security Complex
Radiological Control Organization
Technical Basis Document

Technical Basis

For

The Determination of the Toxicity of Highly Enriched Uranium At The Y-12 National Security Complex

October 19, 2017

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This document has been approved for release to the public by:
S.A. HAWKS 1/16/18
NPO ~~Y-12 Site~~ Office Classification Officer Date

Technical Basis
For
The Determination of the Toxicity of Highly Enriched Uranium
At The Y-12 National Security Complex

October 19, 2017

Kyle R (KRP) Kleinhans

Digitally signed by Kyle R (KRP) Kleinhans
DN: c=US, o=U.S. Government, ou=Department of Energy, ou=Y-12 National Security Complex, ou=CAs, ou=people, cn=Kyle R (KRP) Kleinhans
Date: 2017.10.19 12:50:35 -04'00'

Prepared by: _____

K.R. Kleinhans, CHP, Radiological Engineer

Jeffry T (QJF) Bruner

Digitally signed by Jeffry T (QJF) Bruner
DN: c=US, o=U.S. Government, ou=Department of Energy, ou=Y-12 National Security Complex, ou=CAs, ou=people, cn=Jeffry T (QJF) Bruner
Date: 2017.10.24 11:04:01 -04'00'

Approved by: _____

J.T. Bruner, CHP, Radiological Engineering Manager

Prepared by the
Radiological Control Organization
Y-12 National Security Complex
Oak Ridge, Tennessee 37831
managed by
Consolidated Nuclear Security, LLC
for the
U.S. DEPARTMENT OF ENERGY

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1.0 EXECUTIVE SUMMARY

Regulatory definitions for low-toxicity alpha emitters are inconsistent amongst international and United States regulations. There is some debate amongst hazardous material shippers if Uranium-234 should be considered a high toxicity hazard or a low toxicity hazards. The radiological aspects (specific activity, dose coefficients, dosimetric models) of Uranium-234 have been evaluated and it has been determined that Y-12 will consider Uranium-234 as a low-toxicity hazard.

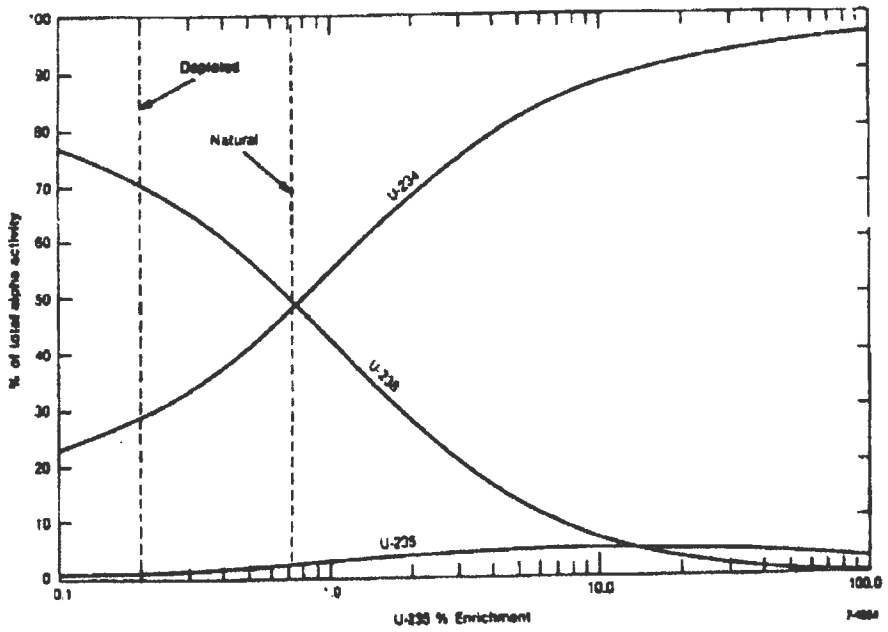
2.0 INTRODUCTION

Y-12 has historically considered all enrichments of uranium to be low toxicity alpha emitters in regards to compliance with DOT regulations. The DOT regulations, specifically 49CFR173.403 are somewhat ambiguous in regards to the toxicity of Highly Enriched Uranium (HEU). As can be seen from Figure 2-2 from DOE-STD-1136-2009, *Guide to Good Practice for Occupational Radiological Protection in Uranium Facilities*, by about 1 wt% the U-234 alpha activity exceeds 50% of the total alpha activity. Between 10 wt% and 20 wt%, the U-234 alpha activity accounts for approximately 50% - 70% of the total alpha activity. Therefore in all HEU, defined as greater than 20 wt%, the toxicity of the U-234 would determine the toxicity of the uranium.

DOE-STD-1136-2009
Guide of Good Practices for Occupational Radiological Protection in Uranium Facilities

Figure 2-2. % Total Radioactivity by Isotope vs. % Weight ^{235}U Enrichment

Calculated from SA = (0.4 + 0.38E+0.0034E^2) 10^{-6} Ci/g (gaseous diffusion process)
(NRC Reg Guide 8.11)



3.0 PREVIOUS DEPARTMENT OF ENERGY DIRECTION

In October 2011, the U.S. Department of Energy/Oak Ridge Operations, Science Integrated Support Center, published a Packaging and Transportation Safety Regulatory Bulletin that stated enriched uranium is considered a low-toxicity alpha emitter. This analysis recognized the lack of harmonization between international and United States transportation regulation, and based its interpretation on technical references.

4.0 REGULATORY DEFINITIONS OF LOW TOXICITY ALPHA EMITTERS

IAEA Specific Safety Requirements (SSR-6), *Regulations for the Safe Transport of Radioactive Material:*
227.*Low toxicity alpha emitters* are: *natural uranium*, *depleted uranium*, natural thorium, uranium-235, uranium-238, thorium-232, thorium-228 and thorium-230 when contained in ores or physical and chemical concentrates; or alpha emitters with a half-life of less than 10 days.

IAEA Specific Safety Guide (SSG-26), *Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material:*
227.1. The identification of low toxicity alpha emitters is based on the specific activity of the radionuclide (or the radionuclide in its 'as shipped' state). For a nuclide with a very LSA, its intake cannot, because of its bulk, be reasonably expected to give rise to doses approaching the dose limit. The radionuclides U-235, U-238 and Th-232 have specific activities four to eight orders of magnitude lower than Pu-238 or Pu-239 (4×10^3 to 8×10^4 Bq/g as opposed to 2×10^9 to 6×10^{11} Bq/g). Although Th-228 and Th-230 have specific activities comparable to those of Pu-238 and Pu-239, they are only allowed as 'low toxicity alpha emitters' when contained in ores and physical and chemical concentrates, which inherently provides for the low activity concentration required.

49CFR173.403 (current as of July 21, 2017)
Low toxicity alpha emitters means natural uranium; depleted uranium; natural thorium; uranium-235 or uranium-238; thorium-232; thorium-228 and thorium-230 when contained in ores or physical and chemical concentrates; and alpha emitters with a half-life of less than 10 days.

5.0 SPECIFIC ACTIVITY

Based upon use of the specific activity in the definition of Low Toxicity Alpha Emitters in IAEA SSG-26, the specific activity of both 20 wt% and 93 wt% uranium have specific activities three to six orders of magnitude lower than Pu-238 or Pu-239 and would be considered low toxicity alpha emitters.

Nuclide	$T_{1/2}$ (Years)	Specific Activity (Bq/g)
Pu-238	87.74	6E+11
Pu-239	24065	2E+09
Th-232	1.405E+01	4E+03
LEU (20 wt%)	N/A	4E+05
HEU (93 wt%)	N/A	2E+06
U-235	703.8E+06	8E+04
U-238	4.468E+09	1E+04

The specific activity for the individual radionuclides were calculated from the half-lives published in ICRP 119. The specific activity for the two enrichments of uranium were calculated from the formula Specific Activity of Enriched Uranium = $(0.4 + 0.38E + 0.0034E^2)10^{-6}$ Ci/g, where E = percent enrichment $\geq$ 0.72 from DOE-STD-1136-2017, Good Practices for Occupational Radiation Protection in Uranium Facilities.

6.0 DOSE CONVERSION FACTORS FROM ICRP 119, *COMPENDIUM OF DOSE COEFFICIENTS BASED ON ICRP PUBLICATION 60*

As demonstrated by ICRP 119, Table A.1, *Effective dose coefficient for ingested and inhaled (AMAD = 1 and 5 μm) particulates by workers*, and Table G.1. *Effective dose coefficients for inhalation of radionuclides by members of the public*, the effective dose coefficients for the U-234 is slightly higher than both U-235 and U-238 but at least an order of magnitude less than that for Th-232. Th-232, not as an ore, is considered a low toxicity alpha emitter, therefore U-234 would also be considered as a low toxicity alpha emitter based upon the effective dose coefficients found in IRCP 119.

Table A.1. Effective dose coefficient for ingested and inhaled particulates for workers.

Nuclide	Effective Dose Coefficient (Sv/Bq) Inhalation					
	AMAD 1μm			AMAD 5μm		
	F	M	S	F	M	S
Th-232	-	4.2E-05	2.3E-05	-	2.9E-05	1.2E-05
U-234	5.5E-07	3.1E-06	8.5E-06	6.4E-07	2.1E-06	6.8E-06
U-235	5.1E-07	2.8E-06	7.7E-06	6.0E-07	1.8E-06	6.1E-06
U-238	4.9E-07	2.6E-06	7.3E-06	5.8E-07	1.6E-06	5.7E-06

Table G.1. Effective dose coefficients for inhalation of radionuclides for adult members of the public.

NUCLIDE	Effective Dose Coefficient (Sv/Bq) Inhalation (AMAD 1μm)		
Type	F	M	S
Th-232	1.1E-04	4.5E-05	2.5E-05
U-234	5.6E-07	3.5E-06	9.4E-06
U-235	5.2E-07	3.1E-06	8.5E-06
U-238	5.0E-07	2.9E-06	8.0E-06

7.0 SUMMARY

IAEA SSG-26 bases the definition of Low Toxicity alpha emitters on the specific activity and the dosimetric aspects of an intake of the material. Highly enriched uranium will be considered a low toxicity alpha emitter based on our evaluation of both components of this definition.

8.0 REFERENCES

- DOE-STD-1136-2009, *DOE Standard, Guide of Good Practices for Occupational Radiological Protection in Uranium Facilities (July 2009)*
- DOE-STD-1136-2017, *Good Practices for Occupational Radiation Protection in Uranium Facilities.*
- DOE/OAK RIDGE PACKAGING AND TRANSPORTATION SAFETY REGULATORY BULLETIN, OCTOBER 2011.
- IAEA Specific Safety Requirements (SSR-6), *Regulations for the Safe Transport of Radioactive Material*
- IAEA Specific Safety Guide (SSG-26), *Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material*
- ICRP, 2012. Compendium of Dose Coefficients based on ICRP Publication 60.ICRP Publication 119
- 49CFR173.403 (current as of July 21, 2017)