Oregon Radioactive Waste Disposal Regulations

Division 50 December 2021 Meeting

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AGENDA

9:00 Welcome and Introductions

9:15 Topic 1: Threshold Concentrations

10:30 Break

10:40 Topic 2: Waste Determination/Disposal Process Flow and Timeline

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Relevant units and terms

- **PicoCurie** – a measure of activity. One pCi is about one trillionth the activity of a gram of pure radium-226
- **Millirem** – a measure of dose. One millirem is a thousandth of a rem (roentgen equivalent man).
- **Leachability** - How much contamination will be passed to water when the water passes through a solid.
- **Half-life** - The time it takes half of a parent isotope to decay into its daughter.
- **Decay** - The process that occurs when an unstable isotope loses energy (emitting radiation) and becomes an isotope of a different element
- **Radon** - A colorless, odorless, radioactive gaseous element that is the product of natural uranium and thorium decay chains and is a leading contributor to lung cancer.
- **Radium** – A naturally occurring metallic element which is part of naturally occurring radioactive decay chains and includes isotopes of interest in public health.
- **NORM** – Naturally Occurring Radioactive Material – Typically refers to "unrefined" materials from the uranium and thorium decay chains, although in some scenarios is only applicable to materials in place
- **TENORM** – technically enhanced NORM- NORM that has been processed to make it either more radioactive or to increase the likelihood of human exposure
- **Exposure scenario / receptor** - A modeled situation in which a receptor (e.g., human, indoor air, plant/animal, groundwater) potentially is impacted by a substance of concern.
- **Pathway** – the method by which a receptor becomes exposed to a constituent of concern (e.g., inhalation of air or dust, ingestion of water, direct "shine")

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Questions for rulemaking

- Are there isotopes that should be specifically added to Table 1 of OAR 345 Division 50?
- Is there any reason to change the threshold concentration of U-238, Ra-226, or Ra-228?
- Should lead-210 receive a specific exemption or be covered under the 10 pCi/g limit for uranium-238?

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Exemptions from the Definition of "Radioactive Waste" under OAR 345 Division 50

- Concentration-based thresholds, regardless of quantity
- Total radioactivity (quantity) thresholds, regardless of concentration
- Specific exemptions
- Pathway Exemption (three tests)

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PRESENTATION BY DOE
TO THE
ENERGY FACILITY SITING COUNCIL
HEARING RELATING TO THE DEFINITION OF
"RADIOACTIVE MATERIALS"

INTRODUCTION

The rule as published in the "Notice of Proposed Adoption of a Rule" was drafted with the intent that the Energy Facility Siting Council would prohibit the disposal of any radioactive materials which present a sufficient risk to public health that their possession and use is required to be licensed by the Health Division. Today, I would like

Basis for Radionuclide Tables 1&2

- Purpose of Table 1 and 2 is to be compatible with Health Division regulations for materials that need a license for possession or use.
- Rationale that since their use is not regulated, regulating disposal would be virtually impossible and even if successful would have little if any impact on public health and safety.
- Table 1 and 2 derive from 10 CFR Part 30 – Rules of General Applicability to Domestic Licensing of Byproduct Material
  - Original reference was Oregon Regulations for the Control of Radiation, originally in Health Division regulations but now deprecated.

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ASSUMPTIONS USED IN REACHING OPTION 2:

1. The rule should be based on current regulatory practices; i.e., if it requires a Health Division License or if it presents a health hazard due to the presence of radioactive materials, it meets the threshold criteria.

2. In considering potential health hazards resulting from the disposal of radioactive materials, the Council should rely on currently-accepted dose and effluent limits rather than debate the merits of higher or lower limits. If accepted dose limits are changed in the future, this, as well as other Council rules, would require reconsideration.

Table 1 NORM limits

- U-238 exemption concentration = 10 pCi/g
- Daughter products of U-238 are not listed in Table 1
- Footnote to Table 1: **Many radioisotopes transform into isotopes that are also radioactive. In expressing the concentrations in Table 1, the activity stated is that of the parent isotope and takes into account the daughters.**
  - Secular equilibrium is tacitly assumed.
  - Clarity needed when waste streams contain daughters without parents

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Specific Exemptions

- Rule 0030 adopts by reference exemptions for certain consumer products in which human-made radioactivity has been incorporated.
- These products are commonly manufactured under an NRC license which determined that unregulated distribution to the public does not pose any hazard to public health and safety.
- Examples include watches, electron tubes, compasses, and smoke detectors.
- Question: Are there other items that warrant a specific exemption?

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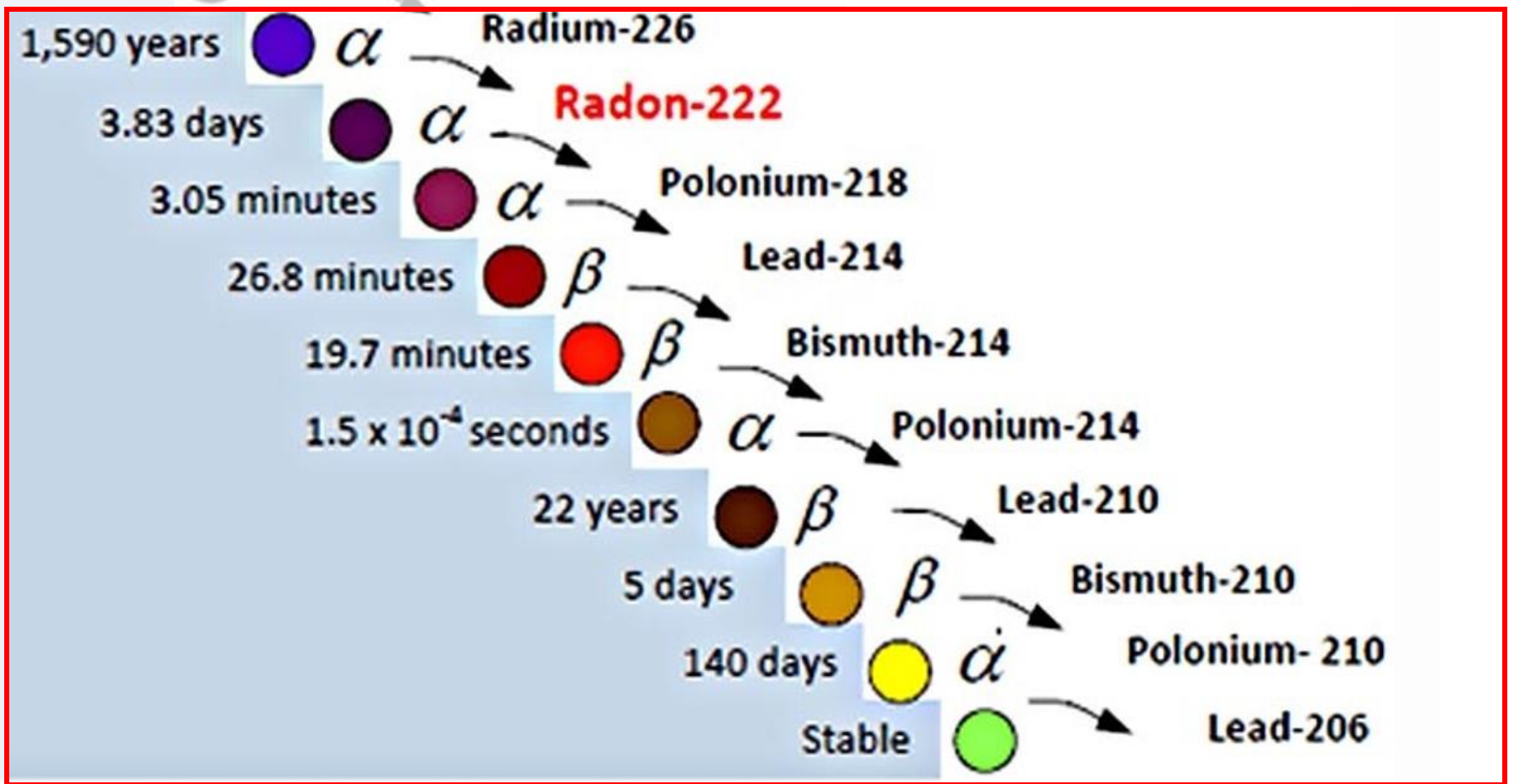
Radium-226


Half-life
1,590 years
α
Radium-226
3.83 days
α
Radon-222
3.05 minutes
α
Polonium-218
26.8 minutes
β
Lead-214
19.7 minutes
β
Bismuth-214
1.5 x 10⁻⁴ seconds
α
Polonium-214
22 years
β
Lead-210
5 days
β
Bismuth-210
140 days
α
Polonium- 210
Stable
Lead-206

Basis for specific exemption for Ra-226

- Ra-226 has specific exemption level of **5 pCi/g** in OAR 345-050-0030
- Many states do not regulate NORM isotopes below 5 pCi/g
  - Typically Ra-226 and Ra-228, but Lead-210 also in some states
- EPA established a radium level of 5 pCi/g above background for uranium mill tailing sites as a protective health-based level for cleanup of soil in the top 15 cm. This cleanup level is often applicable at Superfund sites.

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The additional exemption in Dr. Woods' presentation for materials containing less that 5 pCi/gm of Ra-226 warrants some discussion. Dr. Woods obtained this number from preliminary drafts of EPA's definition of radium bearing radioactive waste to be controlled under the national Resource Conservation and Recovery Act (RCRA). EPA, in turn, based their proposal on actual measurements of radon activity in houses constructed on lands reclaimed from phosphate processing and an extrapolation back to the soil concentration which would result in exceeding 3 pCi/l of Radon-222 in the air in these homes.

However, on March 24, 1978 the U. S. Environmental Protection Agency (EPA) issued draft regulations stating that for radium-226 quantities and concentrations of radium-226 qualifying as radioactive wastes should be greater than 10 microcuries and 5 pico-curies per gram, respectively. This increase by factors of about ten suggests that my proposed rules are adequately conservative.

If a quantity of unencapsulated radium-226 were located directly under a small mobile home, and the assumptions used in proposed Rule 345-50-035 Pathway Exemption were adopted, it would require at least 20 microcuries of radium-226 to create a concentration of 3 picocuries per liter of air within the house. However, a limiting quantity of only 10 microcuries is used in the proposed rule because this is the maximum quantity permitted to be buried in soil by a licensee under 10CFR20.

A. Radium 226 -- exempt below 5 pCi/gm.

The original source of the proposed level was a draft regulation by EPA designed for use in enforcement of the Resource Conservation and Recovery Act (RCRA) provisions for the disposal of hazardous wastes. At the November 3 hearing, the staff noted that this value is based on potential radon buildup in a house constructed on the disposal site. It was also demonstrated that, using a specific model and by the fact that very few references are available relating soil concentration to indoor radon concentrations. The following information is presented by the staff in support of retaining 5 pCi/gm as the level:

1. The reference used by PGE to support the claim that ~~random~~ Radon levels average considerably less than 3 pCi/l contains the statement, "Assuming that a representative value of the average ^{222}Rn concentration indoors is 1 pCi/l ..." (UNSCEAR, 1978 p. 78). In a table values for U-238 in soil (and hence Radium-226) an average value is listed of 0.7 pCi/gm (UNSCEAR, 1978 p. 44). The staff is well aware of the fact that these are not true averages and that an unknown portion of the indoor radon results from the use of building materials containing radium-226 rather than from the soil. This data does not appear to support the contention that the staff assumptions are overly conservative.

2. The "background" value used by EPA and the Colorado Department of Health for radon in houses in Grand Junctin is 0.007 WL (1 pCi/l of Radon-222 equals 0.01 WL if all of the alpha emitting daughters are in equilibrium) at an assumed 50% equilibrium. This approximates 1.4 pCi/l of Radon-222. Soil concentrations in Grand Junction range

from less than 1 pCi/gm to 3 pCi/gm (private communication with Bud Franz, supervisor of Grand Junction Project, Colorado Department of Health.)

3. Data generated by the University of Florida for the Florida Phosphate Council and used by EPA in their draft RCRA standard is the only data the staff has been able to locate which directly relates soil concentration to radon levels. Although this data has apparently not been officially published it strongly suggests that, for phosphate wastes, 5 pCi/gm is a good and perhaps not even very conservative value.

4. A report by J. W. Healy and J. C. Rodgers (Los Alamaos Scientific Laboratory) entitled "A Preliminary Study of Radium Contaminated Soils" (LA-7391-MS, October 1978) has been received by the staff since the November 3 hearing. The purpose of this document is to "provide guidance on limits to be applied in decontaminating land." In that document, Dr. Healy calculates radon levels in homes using two models; one assuming concrete slab construction, the other a crawl space. These values are then related to maximum soil concentrations allowable without exceeding a radon level of 0.01 WL. This value is one-third the limit permitted under the staff proposal. The result of that calculation is the following table:

PERMISSIBLE RADIUM LEVELS IN SOILS TO LIMIT Rn DAUGHTERS IN HOME

Depth of Contaminated Soils (cm)	Soil Type Sand (pCi/g)	Loam (pCi/g)
1	250	150
10	15	15
100	2	3
1000	1	2.7

Dr. Healy notes that "...it is of interest that the EPA in spot sampling of homes in Florida not on reclaimed land have found radon daughter concentrations 2-2½ times the 0.01-WL limit which may indicate that for tightly built homes through the country, the limit of 0.01 WL may be exceeded by the natural radium content of the soils."

This document also evaluates all other pathways of potential human exposure and confirms the fact that radon exposure is the limiting pathway. The summary table from that document is attached to this appendix.

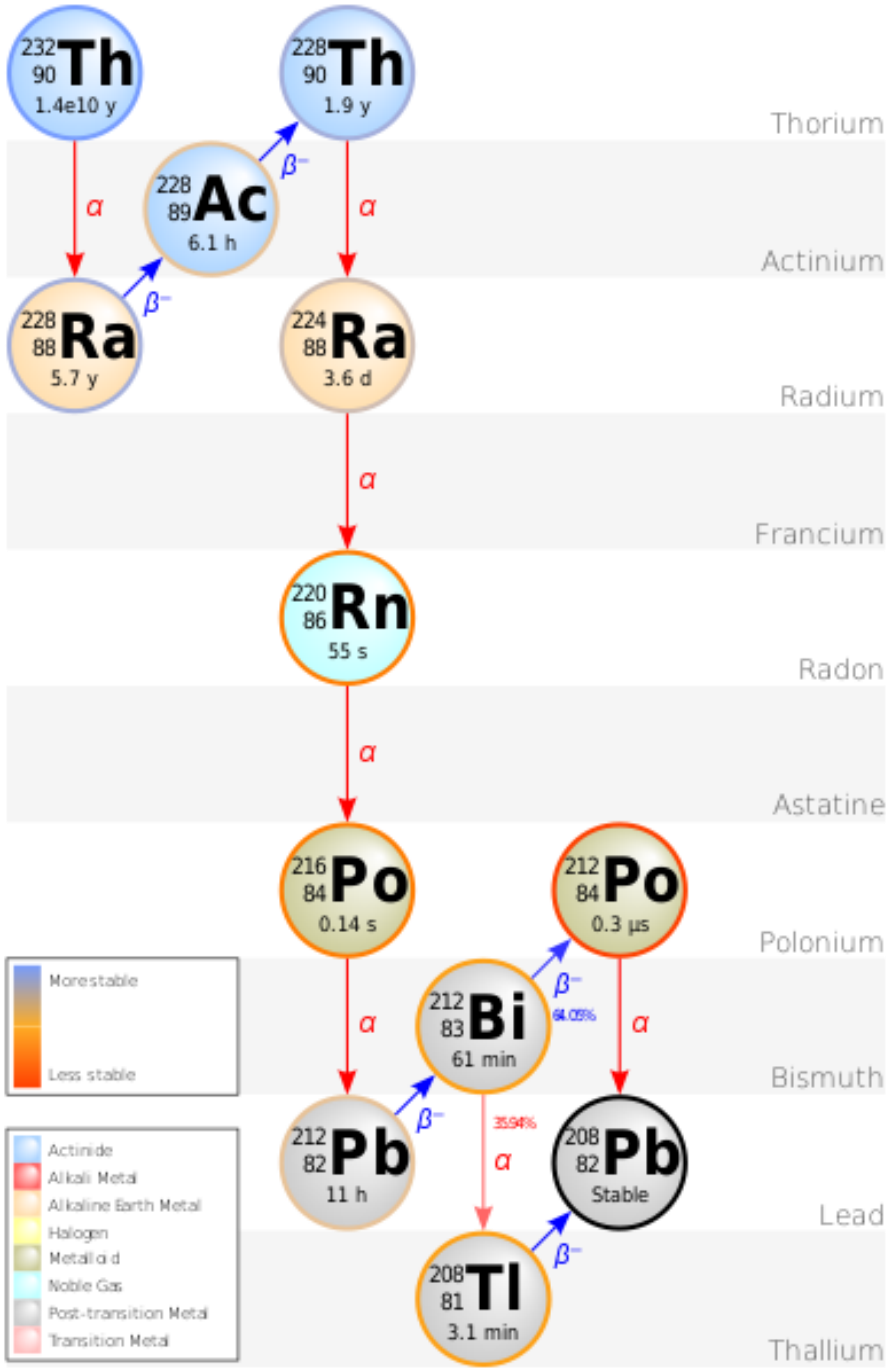
In conclusion, the staff believes that 5 pCi/gm is not overly conservative and that the assumptions used in our calculation of November 3 for radon are reasonable. We feel that potential cases of significant radiation exposure below 5 pCi/gm are rare. We do recognize that some materials exceeding 5 pCi/gm may not present a significant potential for exceeding the referenced health limits, however, we feel that this must be judged on a case-by-case basis.

B. Radium 226 -- exempt below 10 pCi total activity.

This value was also derived from EPA draft rules. It came in turn from 10 CFR 20, "Standards for the Protections Against Radiation". In that context it is the maximum quantity of material which may be disposed of on a licensee's property under certin specified conditions.

RESRAD model results – 5 pCi/g Ra-226

Parameters 5 pCi/g Ra-226	RESRAD default (0.5 air change/hr, 30% gamma shielding, 70% occupancy	Concrete Slab House, 90% occupancy; 1 air change/hr; 50% gamma shielding	Concrete Slab House, 90% occupancy; 1 air change/hr; 30% gamma shielding	Concrete Slab House, 90% occupancy; 1 air change/hr; 30% gamma shielding	Concrete Slab House, 90% occupancy; 1 air change/hr; 30% gamma shielding	No slab, 1 ACH
Depth of waste (ft)	0	0	0	1	6	0
Direct gamma (mrem/yr)	38	28	37	1.2	0	43
Radon dose (mrem/yr)	501	190	190	190	68	979
Radon concentration (pCi/L)	2	1	1	1	0.4	5.3
Plant ingestion dose (mrem/yr)	24	32	32	19	0	24
Total Dose (mrem/yr)	564	253	253	213	68	1047


232 90 Th 1.4e10 y
228 90 Th 1.9 y
228 89 Ac 6.1 h
228 88 Ra 5.7 y
224 88 Ra 3.6 d
220 86 Rn 55 s
216 84 Po 0.14 s
212 84 Po 0.3 µs
212 83 Bi 61 min
212 82 Pb 11 h
208 82 Pb Stable
208 81 Tl 3.1 min
α
β⁻
64.06%
35.94%
Thorium
Actinium
Radium
Francium
Radon
Astatine
Polonium
Bismuth
Lead
Thallium
More stable
Less stable
Actinide
Alkali Metal
Alkaline Earth Metal
Halogen
Metalloid
Noble Gas
Post-transition Metal
Transition Metal

Radium-228

Specific exemptions for Ra-228

(4) Thorium-bearing materials containing less than 20 picocuries of radium-228 per gram of solid, if the radium-228 is present with the parent thorium-232, regardless of quantity.

(5) Thorium-bearing materials containing a total radium-228 activity of less than 100 microcuries, if the radium-228 is present with the parent thorium-232, regardless of concentration in the solid.

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C. Thorium 232 (Radium 228) -- exempt below 10 pCi/gm.

This value was proposed by Dr. Woods as part of his extension of the Health Division exempt contentions table. The identical value appears in the "Suggested State Regulations for the Control of Radiation" from which the Oregon Health Division regulations derive. Health Division has chosen not to adopt this table as it relates to naturally-occurring materials. The staff does feel, however, that this value is significantly above "normal" concentrations, that no few normal wastes will exceed it and those situations requiring a case-by-case evaluation will be minimal.

It is also adequate to protect public health in that the primary pathway of exposure to thorium and its daughters is due to gamma exposures. NCRP Report No. 45, Natural Background Radiation in the United States, reports that soil containing Thorium-232 and its daughters (including Radium-228) will yield an absorbed dose rate in air of 21.6 mrad/y per pCi/gm. Assuming that this value holds for most materials, this will result in a dose of 432 mR/yr. If the Council adopts the staff proposal, materials exceeding this level would be treated on a case-by-case basis.

D. Thorium 232 (radium 228) -- exempt if total quantity is below 100 microcuries.

This value was proposed by Dr. Woods and does not appear to have been based on any other documents. The staff does believe, however, that it is necessary to have a quantity below which a case-by-case evaluation of health impacts could be avoided. Provided the Council adopts the staff recommendation to evaluate such wastes on a case-by-case basis, the staff believes the 100 microcuries (about 1 kg of pure thorium or some larger quantity if it is contained in a mixture) is not unreasonable.

JMP:sj
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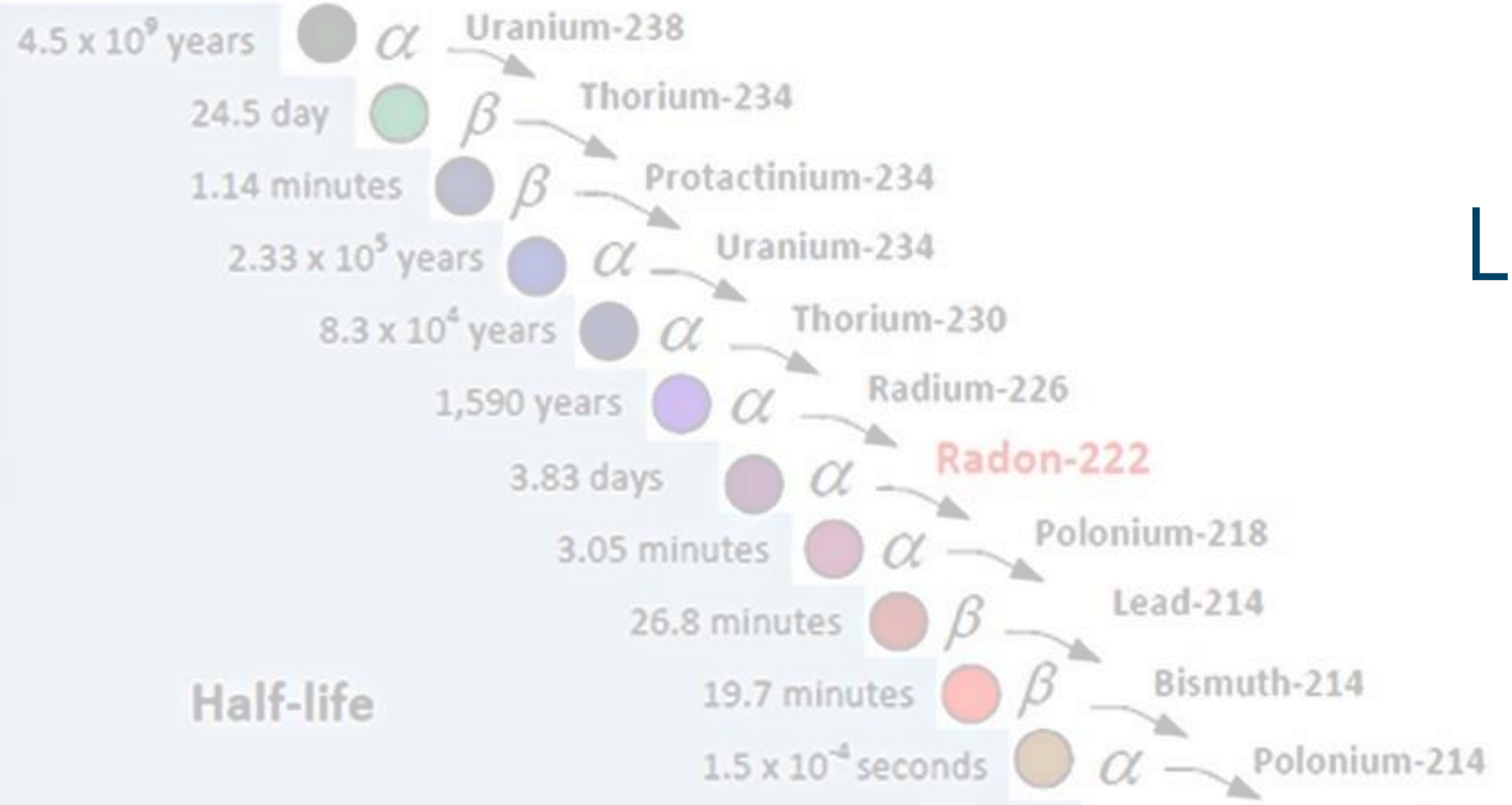
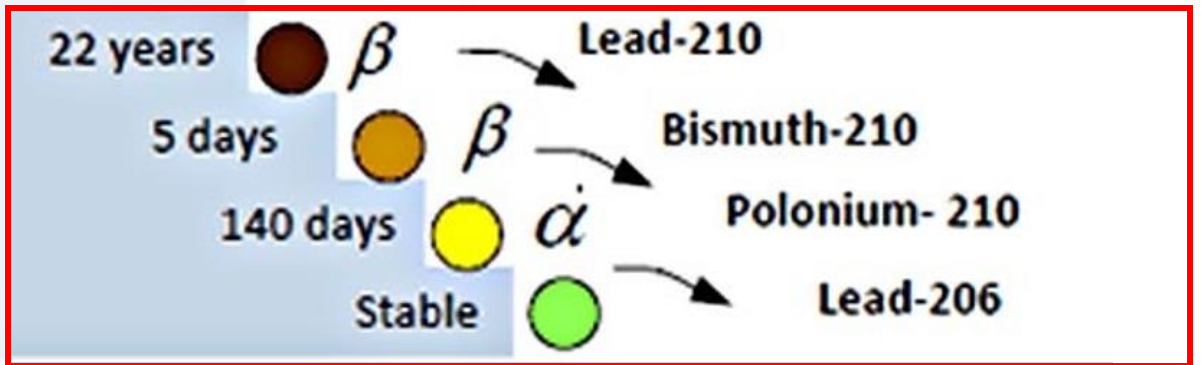
1333A

Rule 345-50-030 Specific Exemption Part (3)

It is futile to permit certain concentrations or quantities of thorium-232 if this results in violating permissible concentrations or quantities of the daughter radium-228. As long as the radium-228 is tied up in rocks with the thorium it should not present a health hazard. The more restrictive limits on radium-228 apply to separated radium which could get into ground water.

Lead-210


4.5 x 10⁹ years
α
Uranium-238
24.5 day
β
Thorium-234
1.14 minutes
β
Protactinium-234
2.33 x 10⁵ years
α
Uranium-234
8.3 x 10⁴ years
α
Thorium-230
1,590 years
α
Radium-226
3.83 days
α
Radon-222
3.05 minutes
α
Polonium-218
26.8 minutes
β
Lead-214
19.7 minutes
β
Bismuth-214
1.5 x 10⁻⁴ seconds
α
Polonium-214
Half-life


22 years
β
Lead-210
5 days
β
Bismuth-210
140 days
α
Polonium- 210
Stable
Lead-206

Lead-210

- **Can be disproportionately high (disequilibrium) in certain oil/gas wastes.**
- 22-year Half-life – relatively rapid decrease in risk
- No radon risk and major gammas already emitted
- Low leachability / mobility to groundwater
- Some states have begun to regulate Pb-210 at 5 pCi/g.
- RESRAD results: 5 pCi/g Lead-210 = 34 mrem/yr
  - 0.02 mrem/yr direct gamma
  - 31 mrem/yr from ingestion of plants (not included in current pathway exemption framework)

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Options for Lead-210

1. **Make explicit that 10 pCi/g is the threshold limit for Lead-210**
2. Choose a different concentration limit

- Question for future meeting: Should the pathway exemption also include plant ingestion?
- Question for future meeting: is the leachability standard for water appropriate?
  - 1991 EPA study recommended drinking water standard of 1 pCi/L (equivalent to 3.3 x 10-5 risk [3 in 100,000])
  - Current Table 3 value = 100 pCi/L (our standard = 25 pCi/L)

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Review: Questions for rulemaking

- Are there isotopes that should be specifically added to Table 1 of OAR 345 Division 50?
- Is there any reason to change the threshold concentration of U-238, Ra-226, or Ra-228?
- Should lead-210 receive a specific exemption or be covered under the 10 pCi/g limit for uranium-238?

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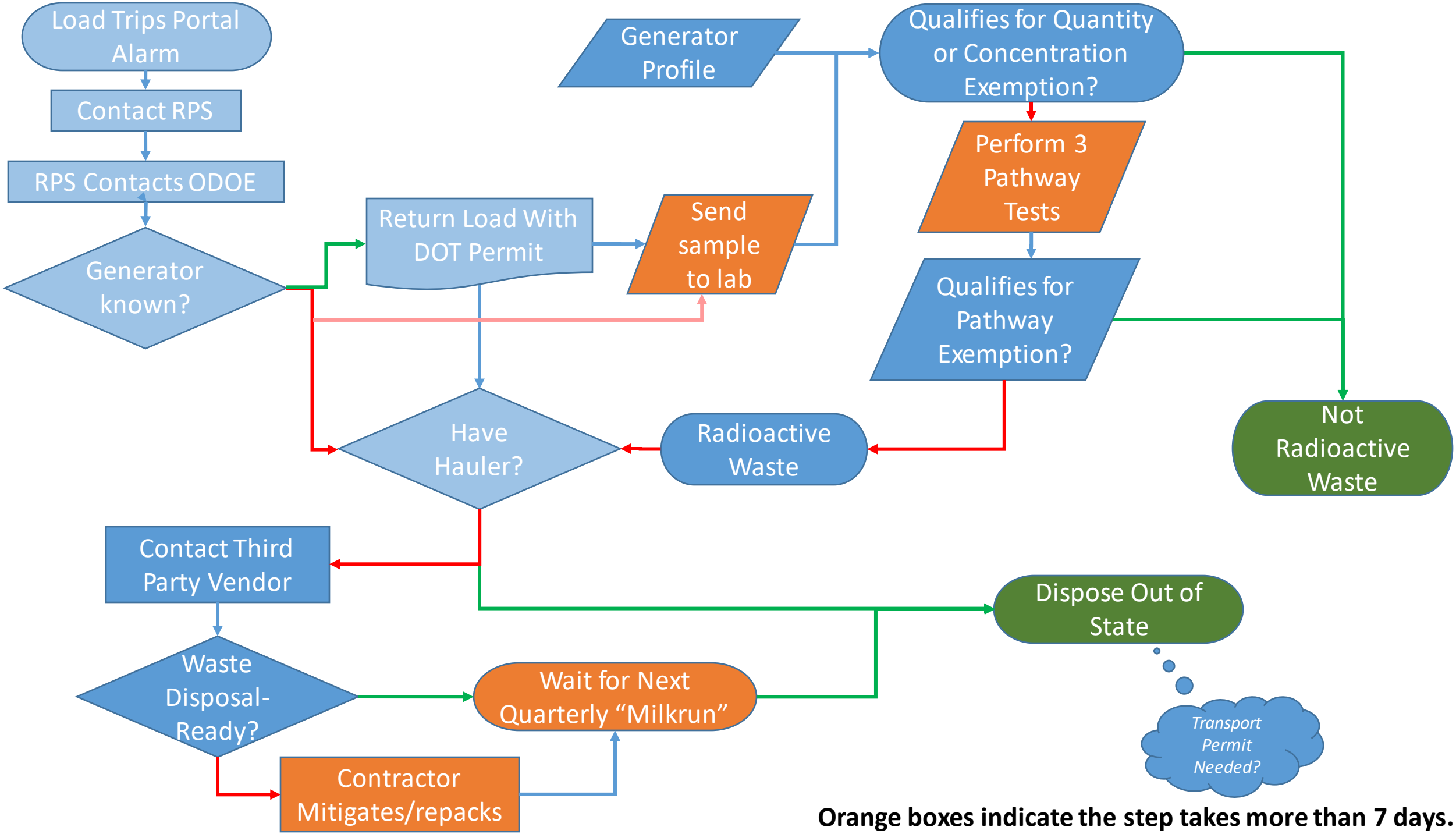
Questions?

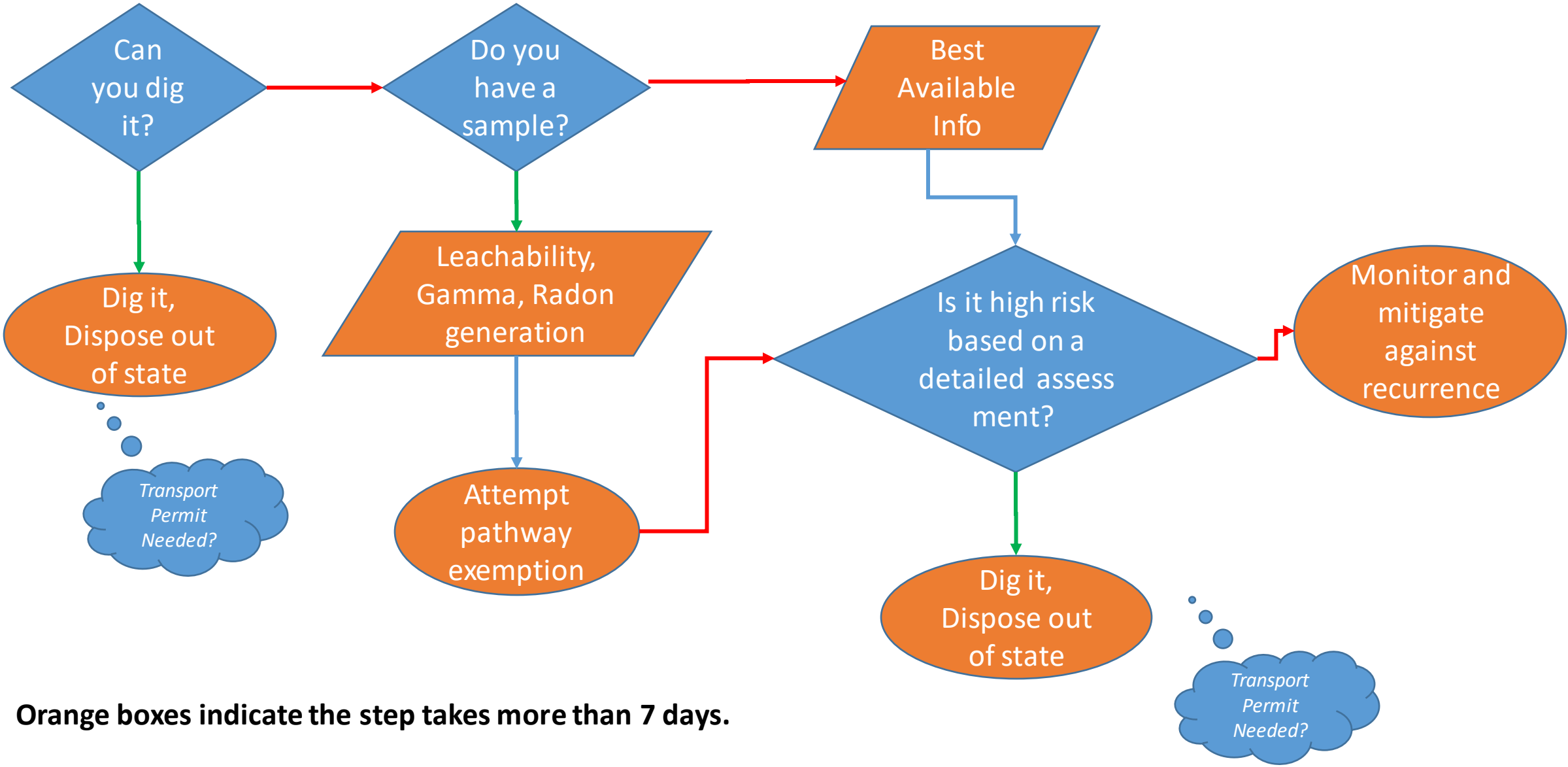
www.oregon.gov/energy | jeff.burright@oregon.gov

Alpha radiation emitting from natural U-238

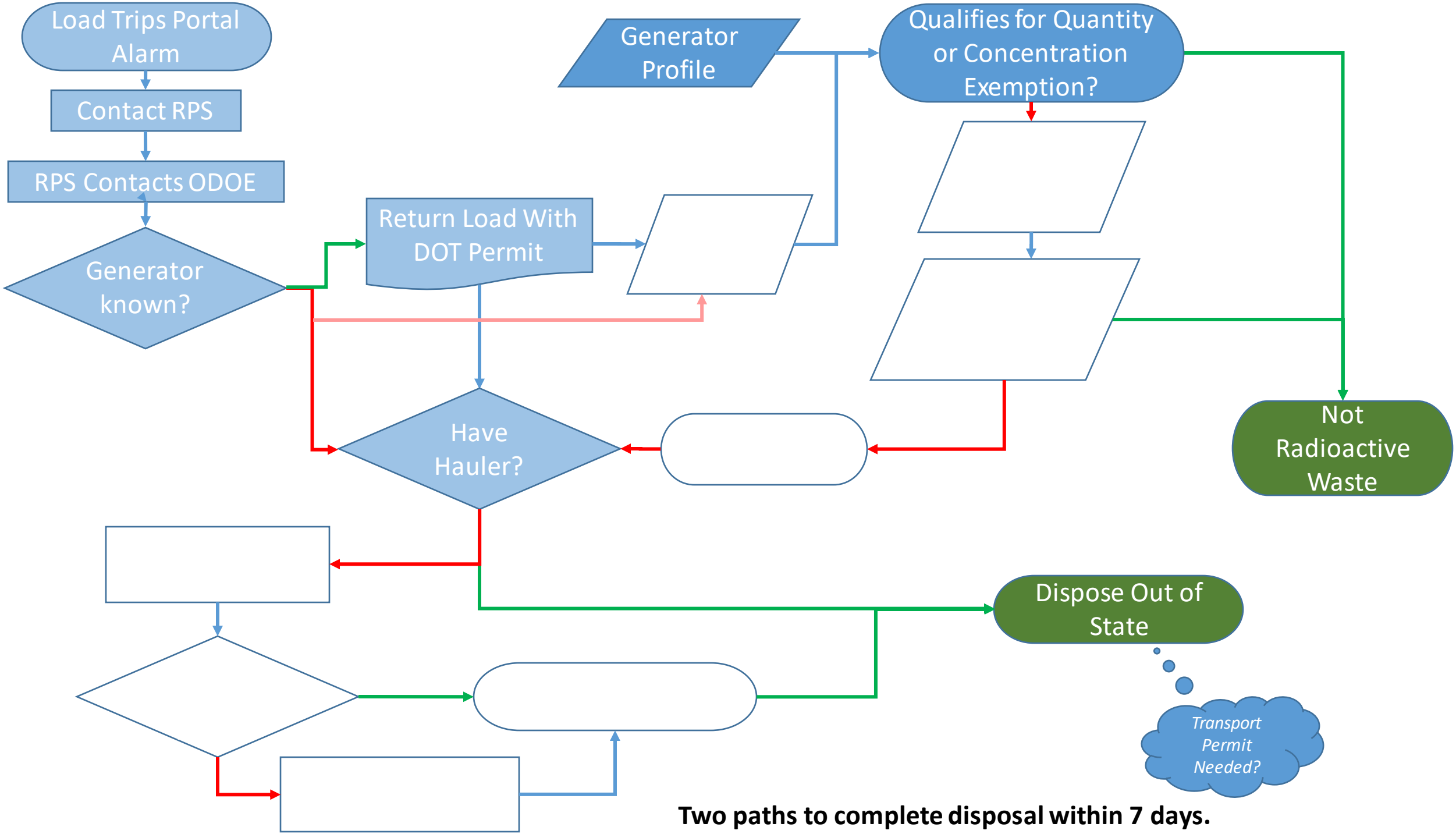


Orange boxes indicate the step takes more than 7 days.

So You Accidentally Disposed of Radioactive Waste…



Orange boxes indicate the step takes more than 7 days.



Two paths to complete disposal within 7 days.