TABLES & GRAPHICS

Graphic images included in rules are published separately in this tables and graphics section. Graphic images are arranged in this section in the following order: Title Number, Part Number, Chapter Number and Section Number.

Graphic images are indicated in the text of the emergency, proposed, and adopted rules by the following tag: the word "Figure" followed by the TAC citation, rule number, and the appropriate subsection, paragraph, subparagraph, and so on.

Figure: 25 TAC §289.201(b)(124)(B)

$$\frac{175\,(\text{grams contained U}-235)}{350}+\frac{50\,(\text{grams U}-233)}{200}+\frac{50\,(\text{grams Pu})}{200}=1$$

Figure: 25 TAC §289.202(ggg)(4)(A)(iii)(V)

Concentration Radionuclide	curie/cubic meter *	nanocurie/gram **
C-14	8	
C-14 in activated metal	80	
Ni-59 in activated metal	220	
Nb-94 in activated metal	0.2	
Tc-99	3	
I-129	0.08	
Alpha emitting transuranic radionuclides with half life greater than 5 years		100
Pu-241		3,500
Cm-242		20,000
Ra-226		100

* To convert the Ci/ m^3 values to gigabecquerel (GBq) per cubic meter, multiply the Ci/ m^3 value by 37.

** To convert the nCi/g values to Becquerel (Bq) per gram, multiply the nCi/g value by 37.

Specific Subsection	Name of Record	Time Interval Required for Record Keeping
(y)(5)	Utilization Records for Portable and Mobile Devices	3 years after the record is made
(ll)(4)	Records at Authorized Use/ Storage Sites	While site is authorized on license/registration
(mm)(1)(A)	Radiation Protection Programs	Until termination of license/registration
(mm)(1)(B)	Program Audits	3 years after the record is made
(nn)(1)	Routine Surveys, Instrument Calibrations and Package Monitoring	3 years after the record is made
(nn)(3)	Surveys; Measurements and/or Calculations Used for Dose Determination; Results of Air Sampling, Surveys and Bioassays; Measurements, Calculations Used to Determine Release of Radioactive Effluents	Until termination of license/registration
(oo)	Tests for leakage/ contamination of sealed sources	5 years after the record is made
(pp)	Lifetime Cumulative Occupational Radiation Dose, RC Form 202-2	Until termination of license
(pp)	Records Used to Prepare RC Form 202-2	3 years after the record is made

Specific Subsection	Name of Record	Time Interval Required for Record Keeping
(qq)	Planned Special Exposures	Until termination of license
(rr)(1) - (3)	Individual Monitoring Results; RC Form 202-3	Entries at no > 1 year intervals, by April 30 each year; Maintain until termination of license/registration
(rr)(5)	Records Used to Prepare RC Form 202-3	3 years after the record is made
(rr)(4)	Embryo/Fetus Dose	Until termination of license/registration
(ss)	Dose to Individual Members of the Public	Until termination of license/registration
(tt)	Discharge, Treatment, or Transfer for Disposal	Until termination of license/registration
(uu)	Entry Control Device Testing for Very High Radiation Areas	3 years after the record is made

NUCLIDE[a]	AVERAGE[bcf]	MAXIMUM[bdf]	REMOVABLE[bcef]
U-nat, U-235, U-238, and associated decay products except Ra-226, Th-230, Ac-227, and Pa-231	5,000 dpm alpha/ 100 cm^2	15,000 dpm alpha/ 100 cm^2	1,000 dpm alpha/ 100 cm^2
Transuranics, Ra-223, Ra-224, Ra-226, Ra-228, Th-nat, Th-228, Th-230, Th-232, U-232, Pa-231, Ac-227, Sr-90, I-129	1,000 dpm/100 cm^2	3,000 dpm/100 cm^2	200 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5,000 dpm beta, gamma/100 cm^2	15,000 dpm beta, gamma/100 cm^2	1,000 dpm beta, gamma/100 cm^2
Tritium (applicable to surface and subsurface)[g]	NA	NA	10,000 dpm/100 cm^2

[a] Where surface contamination by both alpha and beta-gamma emitting nuclides exists, the limits established for alpha and beta-gamma emitting nuclides shall apply independently.

[b] As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[c] Measurements of average contamination level should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each object.

[d] The maximum contamination level applies to an area of not more than 100 cm^2.

[e] The amount of removable radioactive material per 100 cm^2 of surface area shall be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels shall be reduced proportionally and the entire surface shall be wiped.

[f] The radiation levels associated with surface contamination resulting from beta-gamma emitters shall not exceed 0.2 mrad/hr at 1 centimeter for an average and shall not exceed 1.0 mrad/hr at 1 centimeter as a maximum, as measured through not more than 7 mg/cm^2 of total absorber. The external gamma exposure rate shall not exceed 5 microentgen per hour above background at 1 meter from the surface, and for soil 10 microentgen per hour above background at 1 meter.

[g] Property recently exposed or decontaminated, shall have measurements (smears) at regular time intervals to ensure that there is not a build-up of contamination over time. Because tritium typically penetrates material it contacts, the surface guidelines in group 4 are not applicable to tritium. The agency has reviewed the analysis conducted by the Department of Energy Tritium Surface Contamination Limits Committee ("Recommended Tritium Surface Contamination Release Guides," February 1991), and has assessed potential doses associated with the release of property containing residual tritium. The agency recommends the use of the stated guideline as an interim value for removable tritium. Measurements demonstrating compliance of the removable fraction of tritium on surfaces with this guideline are acceptable to ensure that non-removable fractions and residual tritium in mass will not cause exposures that exceed dose limits as specified in this section and agency constraints.

Nuclides	Concentrations Limit (Ci/m^3)	Annual Generator Disposal Limit (Ci/yr)
F-18	3×10^{-1}	8
Si-31	$1 \times 10^{+2}$	$3 \times 10^{+3}$
Na-24	9×10^{-4}	2×10^{-2}
P-32	2	$5 \times 10^{+1}$
P-33	10	$3 \times 10^{+2}$
S-35	9	$2 \times 10^{+2}$
Ar-41	3×10^{-1}	8
K-42	2×10^{-2}	5×10^{-1}
Ca-45	4	$1 \times 10^{+2}$
Ca-47	2×10^{-2}	5×10^{-1}
Sc-46	2×10^{-3}	5×10^{-2}
Cr-51	6×10^{-1}	$2 \times 10^{+1}$
Fe-59	5×10^{-3}	1×10^{-1}
Co-57	6×10^{-2}	2
Co-58	1×10^{-2}	3×10^{-1}
Zn-65	7×10^{-3}	2×10^{-1}
Ga-67	3×10^{-1}	8
Se-75	5×10^{-2}	1
Br-82	2×10^{-3}	5×10^{-2}
Rb-86	4×10^{-2}	1
Sr-85	2×10^{-2}	5×10^{-1}
Sr-89	8	$2 \times 10^{+2}$
Y-90	4	$1 \times 10^{+2}$
Y-91	4×10^{-1}	10
Zr-95	8×10^{-3}	2×10^{-1}
Nb-95	8×10^{-3}	2×10^{-1}
Mo-99	5×10^{-2}	1
Tc-99m	1	$3 \times 10^{+1}$
Rh-106	1	$3 \times 10^{+1}$
Ag-110m	2×10^{-3}	5×10^{-2}
Cd-115m	2×10^{-1}	5
In-111	9×10^{-2}	2

Nuclides	Concentrations Limit (Ci/m^3)	Annual Generator Disposal Limit (Ci/yr)
In-113m	9	$2 \times 10^{+2}$
Sn-113	6×10^{-2}	2
Sn-119	$2 \times 10^{+1}$	$5 \times 10^{+2}$
Sb-124	2×10^{-3}	5×10^{-2}
Te-129	2×10^{-1}	5
I-123	4×10^{-1}	$1 \times 10^{+1}$
I-125	7×10^{-1}	$2 \times 10^{+1}$
I-131	4×10^{-2}	1
I-133	2×10^{-2}	5×10^{-1}
Xe-127	8×10^{-2}	2
Xe-133	1	$3 \times 10^{+1}$
Ba-140	2×10^{-3}	5×10^{-2}
La-140	2×10^{-3}	5×10^{-2}
Ce-141	4×10^{-1}	$1 \times 10^{+1}$
Ce-144	1×10^{-3}	3×10^{-2}
Pr-143	6	$2 \times 10^{+2}$
Nd-147	7×10^{-2}	2
Yb-169	6×10^{-2}	2
Ir-192	1×10^{-2}	3×10^{-1}
Au-198	3×10^{-2}	8×10^{-1}
Hg-197	8×10^{-1}	$2 \times 10^{+1}$
Tl-201	4×10^{-1}	$1 \times 10^{+1}$
Hg-203	1×10^{-1}	3

NOTE: In any case where there is a mixture in waste of more than one radionuclide, the limiting values for purposes of this paragraph shall be determined as follows.

For each radionuclide in the mixture, calculate the ratio between the quantity present in the mixture and the limit established in this paragraph for the specific radionuclide when not in a mixture. The sum of such ratios for all the radionuclides in the mixture may not exceed "1" (i.e., "unity").

Examples: If radionuclides a, b, and c are present in concentrations C_a, C_b, and C_c, and if the applicable concentrations are CL_a, CL_b, and CL_c respectively, then the concentrations shall be limited so that the following relationship exists:

$$(C_a/CL_a) + (C_b/CL_b) + (C_c/CL_c) \leq 1$$

If the total curies for radionuclides a, b, and c are represented A_a, A_b, and A_c, and the annual curie limit for each radionuclide is AL_a, AL_b, and AL_c, then the generator is limited to the following:

$$(A_a/AL_a) + (A_b/AL_b) + (A_c/AL_c) \leq 1$$

Figure: 25 TAC §289.251(f)(4)(D)(iii)(II)(-b-)

The receipt, possession, use, and transfer of this source, Model ______, Serial No.________, are subject to a general license and the regulations of the agency or equivalent regulations of the NRC or any agreement state. Do not remove this label.

CAUTION - RADIOACTIVE MATERIAL - THIS SOURCE CONTAINS RADIUM-226. DO NOT TOUCH RADIOACTIVE PORTION OF THIS SOURCE.

____;
Name of Manufacturer or Initial Transferor

Figure: 25 TAC §289.251(f)(4)(G)(iii)(II)(-b-)

This radioactive material shall be received, acquired, possessed, and used only by physicians, veterinarians, clinical laboratories, or hospitals and only for *in vitro* clinical or laboratory tests not involving internal or external administration of the material, or the radiation therefrom, to human beings or animals. Its receipt, acquisition, possession, use, and transfer are subject to agency rules or equivalent regulations of the NRC or any agreement state.

____

Name of Manufacturer

Element (atomic number)	Isotope	Column I Gas Concentration μCi/ml*	Column II Liquid and Solid Concentration μCi/ml**
Antimony (51)	Sb-122		3×10^{-4}
	Sb-124		2×10^{-4}
	Sb-125		1×10^{-3}
Argon (18)	Ar-37	1×10^{-3}	
	Ar-41	1×10^{-7}	
Arsenic (33)	As-73		5×10^{-3}
	As-74		5×10^{-4}
	As-76		2×10^{-4}
	As-77		8×10^{-4}
Barium (56)	Ba-131		2×10^{-3}
	Ba-140		3×10^{-4}
Beryllium (4)	Be-7		2×10^{-2}
Bismuth (83)	Bi-206		4×10^{-4}
Bromine (35)	Br-82	4×10^{-7}	3×10^{-3}
Cadmium (48)	Cd-109		2×10^{-3}
	Cd-115m		3×10^{-4}
	Cd-115		3×10^{-4}
Calcium (20)	Ca-45		9×10^{-5}
	Ca-47		5×10^{-4}
Carbon (6)	C-14	1×10^{-6}	8×10^{-3}
Cerium (58)	Ce-141		9×10^{-4}
	Ce-143		4×10^{-4}
	Ce-144		1×10^{-4}
Cesium (55)	Cs-131		2×10^{-2}
	Cs-134m		6×10^{-2}
	Cs-134		9×10^{-5}
Chlorine (17)	Cl-138	9×10^{-7}	4×10^{-3}
Chromium (24)	Cr-51		2×10^{-2}
Cobalt (27)	Co-57		5×10^{-3}
	Co-58		1×10^{-3}
	Co-60		5×10^{-4}
Copper (29)	Cu-64		3×10^{-3}

* Values are given in Column I only for those materials normally used in gases.

** μCi/gm for solids

		Column I	Column II
Element (atomic number)	Isotope	Gas Concentration µCi/ml*	Liquid and Solid Concentration µCi/ml**
Dysprosium (66)	Dy-165		4×10^{-3}
	Dy-166		4×10^{-4}
Erbium (68)	Er-169		9×10^{-4}
	Er-171		1×10^{-3}
Europium (63)	Eu-152 (T/2=9.2 h)		6×10^{-4}
	Eu-155		2×10^{-3}
Fluorine (9)	F-18	2×10^{-6}	8×10^{-3}
Gadolinium (64)	Gd-153		2×10^{-3}
	Gd-159		8×10^{-4}
Gallium (31)	Ga-72		4×10^{-4}
Germanium (32)	Ge-71		2×10^{-2}
Gold (79)	Au-196		2×10^{-3}
	Au-198		5×10^{-4}
	Au-199		2×10^{-3}
Hafnium (72)	Hf-181		7×10^{-4}
Hydrogen (1)	H-3	5×10^{-6}	3×10^{-2}
Indium (49)	In-113m		1×10^{-2}
	In-114m		2×10^{-4}
Iodine (53)	I-126	3×10^{-9}	2×10^{-5}
	I-131	3×10^{-9}	2×10^{-5}
	I-132	8×10^{-8}	6×10^{-4}
	I-133	1×10^{-8}	7×10^{-5}
	I-134	2×10^{-7}	1×10^{-3}
Iridium (77)	Ir-190		2×10^{-3}
	Ir-192		4×10^{-4}
	Ir-194		3×10^{-4}
Iron (26)	Fe-55		8×10^{-3}
	Fe-59		6×10^{-4}
Krypton (36)	Kr-85m	1×10^{-6}	
	Kr-85	3×10^{-6}	
Lanthanum (57)	La-140		2×10^{-4}
Lead (82)	Pb-203		4×10^{-3}

* Values are given in Column I only for those materials normally used in gases.
** µCi/gm for solids

Element (atomic number)	Isotope	Column I Gas Concentration µCi/ml*	Column II Liquid and Solid Concentration µCi/ml**
Lutetium (71)	Lu-177		1×10^{-3}
Manganese (25)	Mn-52		3×10^{-4}
	Mn-54		1×10^{-3}
	Mn-56		1×10^{-3}
Mercury (80)	Hg-197m		2×10^{-3}
	Hg-197		3×10^{-3}
	Hg-203		2×10^{-4}
Molybdenum (42)	Mo-99		2×10^{-3}
Neodymium (60)	Nd-147		6×10^{-4}
	Nd-149		3×10^{-3}
Nickel (28)	Ni-65		1×10^{-3}
Niobium (Columbium) (41)	Nb-95		1×10^{-3}
	Nb-97		9×10^{-3}
Osmium (76)	Os-185		7×10^{-4}
	Os-191m		3×10^{-2}
	Os-191		2×10^{-3}
	Os-193		6×10^{-4}
Palladium (46)	Pd-103		3×10^{-3}
	Pd-109		9×10^{-4}
Phosphorus (15)	P-32		2×10^{-4}
Platinum (78)	Pt-191		1×10^{-3}
	Pt-193m		1×10^{-2}
	Pt-197m		1×10^{-2}
	Pt-197		1×10^{-3}
Potassium (19)	K-42		3×10^{-3}
Praseodymium	Pr-142		3×10^{-4}
	Pr-143		5×10^{-4}
Promethium (61)	Pm-147		2×10^{-3}
	Pm-149		4×10^{-4}

* Values are given in Column I only for those materials normally used in gases.

** µCi/gm for solids

Element (atomic number)	Isotope	Column I Gas Concentration µCi/ml*	Column II Liquid and Solid Concentration µCi/ml**
Rhenium (75)	Re-183		6×10^{-3}
	Re-186		9×10^{-4}
	Re-188		6×10^{-4}
Rhodium (45)	Rh-103m		1×10^{-1}
	Rh-105		1×10^{-3}
Rubidium (37)	Rb-86		7×10^{-4}
Ruthenium (44)	Ru-97		4×10^{-4}
	Ru-103		8×10^{-4}
	Ru-105		1×10^{-3}
	Ru-106		1×10^{-4}
Samarium (62)	Sm-153		8×10^{-4}
Scandium (21)	Sc-46		4×10^{-4}
	Sc-47		9×10^{-4}
	Sc-48		3×10^{-4}
Selenium (34)	Se-75		3×10^{-3}
Silicon (14)	Si-31		9×10^{-3}
Silver (47)	Ag-105		1×10^{-3}
	Ag-110m		3×10^{-4}
	Ag-111		4×10^{-4}
Sodium (11)	Na-24		2×10^{-3}
Strontium (38)	Sr-85		1×10^{-3}
	Sr-89		1×10^{-4}
	Sr-91		7×10^{-4}
	Sr-92		7×10^{-4}
Sulfur (16)	S-35	9×10^{-8}	6×10^{-4}
Tantalum (73)	Ta-182		4×10^{-4}
Technetium (43)	Tc-96m		1×10^{-1}
	Tc-96		1×10^{-3}

* Values are given in Column I only for those materials normally used in gases.

** µCi/gm for solids

Element (atomic number)	Isotope	Column I Gas Concentration μCi/ml*	Column II Liquid and Solid Concentration μCi/ml**
Tellurium (52)	Te-125m		2×10^{-3}
	Te-127m		6×10^{-4}
	Te-127		3×10^{-3}
	Te-129m		3×10^{-4}
	Te-131m		6×10^{-4}
	Te-132		3×10^{-4}
Terbium (65)	Tb-160		4×10^{-4}
Thallium (81)	Tl-200		4×10^{-3}
	Tl-201		3×10^{-3}
	Tl-202		1×10^{-3}
	Tl-204		1×10^{-3}
Thulium (69)	Tm-170		5×10^{-4}
	Tm-171		5×10^{-3}
Tin (50)	Sn-113		9×10^{-4}
	Sn-125		2×10^{-4}
Tungsten (Wolfram) (74)	W-181		4×10^{-3}
	W-187		7×10^{-4}
Vanadium (23)	V-48		3×10^{-4}
Xenon (54)	Xe-131m	4×10^{-6}	
	Xe-133	3×10^{-6}	
	Xe-135	1×10^{-6}	
Ytterbium (70)	Yb-175		1×10^{-3}
Yttrium (39)	Y-90		2×10^{-4}
	Y-91m		3×10^{-2}
	Y-91		3×10^{-4}
	Y-92		6×10^{-4}
	Y-93		3×10^{-4}
Zinc (30)	Zn-65		1×10^{-3}
	Zn-69m		7×10^{-4}
	Zn-69		2×10^{-2}

* Values are given in Column I only for those materials normally used in gases.

** μCi/gm for solids

Element (atomic number)	Isotope	Column I Gas Concentration μCi/ml*	Column II Liquid and Solid Concentration μCi/ml**
Zirconium (40)	Zr-95		6×10^{-4}
	Zr-97		2×10^{-4}
Beta and/or gamma emitting radioactive material not listed above with half-life less than 3 years		1×10^{-10}	1×10^{-6}

NOTE 1: Many radioisotopes disintegrate into isotopes that are also radioactive. In expressing the concentrations in this paragraph, the activity stated is that of the parent isotope and takes into account the daughters.

NOTE 2: For purposes of subsection (d) of this section where a combination of isotopes is involved, the limit for the combination should be derived as follows: Determine for each isotope in the product the ratio between the concentration present in the product and the exempt concentration established in this paragraph for the specific isotope when not in combination. The sum of such ratios may not exceed "1" (for example, unity).

EXAMPLE:

$$\frac{\text{Concentration of Isotope A in Product}}{\text{Exempt Concentration of Isotope A}} + \frac{\text{Concentration of Isotope B in Product}}{\text{Exempt Concentration of Isotope B}} \leq 1$$

* Values are given in Column I only for those materials normally used in gases.

** μCi/gm for solids

Radioactive Material	Microcuries
Antimony-122 (Sb-122)	100
Antimony-124 (Sb-124)	10
Antimony-125 (Sb-125)	10
Arsenic-73 (As-73)	100
Arsenic-74 (As-74)	10
Arsenic-76 (As-76)	10
Arsenic-77 (As-77)	100
Barium-131 (Ba-131)	10
Barium-133 (Ba-133)	10
Barium-140 (Ba-140)	10
Bismuth-210 (Bi-210)	1
Bromine-82 (Br-82)	10
Cadmium-109 (Cd-109)	10
Cadmium-115m (Cd-115m)	10
Cadmium-115 (Cd-115)	100
Calcium-45 (Ca-45)	10
Calcium-47 (Ca-47)	10
Carbon-14 (C-14)	100
Cerium-141 (Ce-141)	100
Cerium-143 (Ce-143)	100
Cerium-144 (Ce-144)	1
Cesium-129 (Cs-129)	100
Cesium-131 (Cs-131)	1,000
Cesium-134m (Cs-134m)	100
Cesium-134 (Cs-134)	1
Cesium-135 (Cs-135)	10
Cesium-136 (Cs-136)	10
Cesium-137 (Cs-137)	10
Chlorine-36 (Cl-36)	10
Chlorine-38 (Cl-38)	10
Chromium-51 (Cr-51)	1,000
Cobalt-57 (Co-57)	100
Cobalt-58m (Co-58m)	10
Cobalt-58 (Co-58)	10
Cobalt-60 (Co-60)	1
Copper-64 (Cu-64)	100
Dysprosium-165 (Dy-165)	10
Dysprosium-166 (Dy-166)	100

Radioactive Material	Microcuries
Erbium-169 (Er-169)	100
Erbium-171 (Er-171)	100
Europium-152 (Eu-152) 9.2h	100
Europium-152 (Eu-152) 13 yr	1
Europium-154 (Eu-154)	1
Europium-155 (Eu-155)	10
Fluorine-18 (F-18)	1,000
Gadolinium-153 (Gd-153)	10
Gadolinium-159 (Gd-159)	100
Gallium-67 (Ga-67)	100
Gallium-72 (Ga-72)	10
Germanium-68 (Ge-68)	10
Germanium-71 (Ge-71)	100
Gold-195 (Au-195)	10
Gold-198 (Au-198)	100
Gold-199 (Au-199)	100
Hafnium-181 (Hf-181)	10
Holmium-166 (Ho-166)	100
Hydrogen-3 (H-3)	1,000
Indium-111 (In-111)	100
Indium-113m (In-113m)	100
Indium-114m (In-114m)	10
Indium-115m (In-115m)	100
Indium-115 (In-115)	10
Iodine-123 (I-123)	100
Iodine-125 (I-125)	1
Iodine-126 (I-126)	1
Iodine-129 (I-129)	0.1
Iodine-131 (I-131)	1
Iodine-132 (I-132)	10
Iodine-133 (I-133)	1
Iodine-134 (I-134)	10
Iodine-135 (I-135)	10
Iridium-192 (Ir-192)	10
Iridium-194 (Ir-194)	100
Iron-52 (Fe-52)	10
Iron-55 (Fe-55)	100
Iron-59 (Fe-59)	10
Krypton-85 (Kr-85)	100

Radioactive Material	Microcuries
Krypton-87 (Kr-87)	10
Lanthanum-140 (La-140)	10
Lutetium-177 (Lu-177)	100
Manganese-52 (Mn-52)	10
Manganese-54 (Mn-54)	10
Manganese-56 (Mn-56)	10
Mercury-197m (Hg-197m)	100
Mercury-197 (Hg-197)	100
Mercury-203 (Hg-203)	10
Molybdenum-99 (Mo-99)	100
Neodymium-147 (Nd-147)	100
Neodymium-149 (Nd-149)	100
Nickel-59 (Ni-59)	100
Nickel-63 (Ni-63)	10
Nickel-65 (Ni-65)	100
Niobium-93m (Nb-93m)	10
Niobium-95 (Nb-95)	10
Niobium-97 (Nb-97)	10
Osmium-185 (Os-185)	10
Osmium-191m (Os-191m)	100
Osmium-191 (Os-191)	100
Osmium-193 (Os-193)	100
Palladium-103 (Pd-103)	100
Palladium-109 (Pd-109)	100
Phosphorus-32 (P-32)	10
Platinum-191 (Pt-191)	100
Platinum-193m (Pt-193m)	100
Platinum-193 (Pt-193)	100
Platinum-197m (Pt-197m)	100
Platinum-197 (Pt-197)	100
Polonium-210 (Po-210)	0.1
Potassium-42 (K-42)	10
Potassium-43 (K-43)	10
Praseodymium-142 (Pr-142)	100
Praseodymium-143 (Pr-143)	100
Promethium-147 (Pm-147)	10
Promethium-149 (Pm-149)	10
Rhenium-186 (Re-186)	100
Rhenium-188 (Re-188)	100

Radioactive Material	Microcuries
Rhodium-103m (Rh-103m)	100
Rhodium-105 (Rh-105)	100
Rubidium-81 (Rb-81)	10
Rubidium-86 (Rb-86)	10
Rubidium-87 (Rb-87)	10
Ruthenium-97 (Ru-97)	100
Ruthenium-103 (Ru-103)	10
Ruthenium-105 (Ru-105)	10
Ruthenium-106 (Ru-106)	1
Samarium-151 (Sm-151)	10
Samarium-153 (Sm-153)	100
Scandium-46 (Sc-46)	10
Scandium-47 (Sc-47)	100
Scandium-48 (Sc-48)	10
Selenium-75 (Se-75)	10
Silicon-31 (Si-31)	100
Silver-105 (Ag-105)	10
Silver-110m (Ag-110m)	1
Silver-111 (Ag-111)	100
Sodium-22 (Na-22)	10
Sodium-24 (Na-24)	10
Strontium-85 (Sr-85)	10
Strontium-89 (Sr-89)	1
Strontium-90 (Sr-90)	0.1
Strontium-91 (Sr-91)	10
Strontium-92 (Sr-92)	10
Sulphur-35 (S-35)	100
Tantalum-182 (Ta-182)	10
Technetium-96 (Tc-96)	10
Technetium-97m (Tc-97m)	100
Technetium-97 (Tc-97)	100
Technetium-99m (Tc-99m)	100
Technetium-99 (Tc-99)	10
Tellurium-125m (Te-125m)	10
Tellurium-127m (Te-127m)	10
Tellurium-127 (Te-127)	100
Tellurium-129m (Te-129m)	10
Tellurium-129 (Te-129)	100
Tellurium-131m (Te-131m)	10

Radioactive Material	Microcuries
Tellurium-132 (Te-132)	10
Terbium-160 (Tb-160)	10
Thallium-200 (Tl-200)	100
Thallium-201 (Tl-201)	100
Thallium-202 (Tl-202)	100
Thallium-204 (Tl-204)	10
Thulium-170 (Tm-170)	10
Thulium-171 (Tm-171)	10
Tin-113 (Sn-113)	10
Tin-125 (Sn-125)	10
Tungsten-181 (W-181)	10
Tungsten-185 (W-185)	10
Tungsten-187 (W-187)	100
Vanadium-48 (V-48)	10
Xenon-131m (Xe-131m)	1,000
Xenon-133 (Xe-133)	100
Xenon-135 (Xe-135)	100
Ytterbium-175 (Yb-175)	100
Yttrium-87 (Y-87)	10
Yttrium-88 (Y-88)	10
Yttrium-90 (Y-90)	10
Yttrium-91 (Y-91)	10
Yttrium-92 (Y-92)	100
Yttrium-93 (Y-93)	100
Zinc-65 (Zn-65)	10
Zinc-69m (Zn-69m)	100
Zinc-69 (Zn-69)	1,000
Zirconium-93 (Zr-93)	10
Zirconium-95 (Zr-95)	10
Zirconium-97 (Zr-97)	10
Any radioactive material not listed above other than alpha emitting radioactive material	0.1

Figure: 25 TAC §289.252(l)(1)(C)(iii)(II)

The receipt, possession, use, and transfer of this device, Model _______, Serial No. _______, are subject to a general license or an equivalent license of the agency, the NRC, or any agreement state. This label shall be maintained on the device in a legible condition. Removal of this label is prohibited.

CAUTION-RADIOACTIVE MATERIAL _______________________________ (Name of Manufacturer or Distributor);

Figure: 25 TAC §289.252(p)(3)(B)

This radioactive material may be received, acquired, possessed, and used only by physicians, veterinarians, clinical laboratories, or hospitals and only for *in vitro* clinical or laboratory tests not involving internal or external administration of the material, or the radiation therefrom, to human beings or animals. Its receipt, acquisition, possession, use, and transfer are subject to the regulations of the agency, the NRC, or any agreement state.

____________________; and
Name of Manufacturer

Figure: 25 TAC §289.252(jj)(2)

RADIONUCLIDES	Limit	Unsealed Sources			Sealed Sources
		10^3	10^4	10^5	10^{10}
Pr-141 Gd-152 Bi-209m U-232 Pu-240 Cm-245 Cf-252 Ce-142 Dy-154 Po-208 U-233 Pu-241 Cm-246 Es-254 Nd-144 Dy-156 Po-209 U-234 Pu-242 Cm-247 Nd-145 Tb-159 Po-210 U-235 Pu-244 Cm-248 Sm-146 Ho-165 Ra-226 U-236 Am-241 Bk-247 Sm-147 Hf-174 Ac-227 Np-235 Am-242m Bk-249 Sm-148 W-180 Th-228 Np-237 Am-243 Cf-248 Gd-148 Pt-190 Th-229 Pu-236 Cm-242 Cf-249 Gd-150 Pb-210 Th-230 Pu-238 Cm-243 Cf-250 Gd-151 Bi-209 Pa-231 Pu-239 Cm-244 Cf-251 and any alpha-emitting radionuclide not listed above or mixtures of unknown alpha emitters of unknown composition.	0.01 µCi	0.01 mCi	0.1 mCi	1.0 mCi	100 Ci
Be-10 Fe-60 Rh-102 Te-123 Sm-145 Lu-175 Ir-199m Al-26 Zn-70 Pd-107 Te-130 Nd-150 Lu-176 Pt-192 Si-32 Ge-68 Ag-108m I-129 Eu-150 Lu-177m Pt-198 Ar-39 Ge-76 Cd-113m La-137 Tb-157 Hf-172 Hg-194 K-40 Kr-81 Cd-116 La-138 Tb-158 Hf-182 Pb-202 Ar-42 Sr-90 Sn-121m Ce-139 Dy-159 Ta-179 Pb-205 Ca-48 Zr-96 Sn-123 Pm-143 Ho-166m Re-184m Bi-208 Ti-44 Mo-100 Sn-124 Pm-144 Lu-173 Re-187 Ra-228 V-49 Tc-98 Sn-126 Pm-145 Lu-174 Re-189 Np-236 V-50 Rh-101 Te-121m Pm-146 Lu-174m Os-194 Bk-248 and any other alpha-emitting radionuclides not listed above or mixtures of beta emitters of unknown composition.	0.1 µCi	0.1 mCi	1.0 mCi	10 mCi	1.0 kCi
Na-22 Ru-106 Cs-134 Eu-152 Bi-210 U (natural) Co-60 Ag-110m Ce-144 Eu-154 Th (natural)	1.0 µCi	1.0 mCi	10 mCi	100 mCi	10 kCi
Cl-36 Ni-63 Rb-87 Cd-109 Ba-133 Gd-153 Tm-171 Ca-45 Zn-65 Zr-93 In-115 Ba-135 Eu-155 W-181 Mn-54 Se-75 Nb-93m Sb-125 Cs-137 Tm-170 Tl-204	10 µCi	10 mCi	100 mCi	1.0 Ci	100 kCi
C-14, Co-57 Kr-85 Tc-99 Ir-194 U-238 Fe-55 Ni-59 Tc-97 Pt-193 Th-232	100 µCi	100 mCi	1.0 Ci	10 Ci	1.0MCi
H-3	1.0 mCi	1 Ci	10 Ci	100 Ci	10 MCi

Figure: 25 TAC §289.252(jj)(7)

Radioactive Material*	Release Fraction	Quantity (curies)
Ac-228 (89)	0.001	4,000
Am-241 (95)	0.001	2
Am-242 (95)	0.001	2
Am-243 (95)	0.001	2
Sb-124 (51)	0.01	4,000
Sb-126 (51)	0.01	6,000
Ba-133 (56)	0.01	10,000
Ba-140 (56)	0.01	30,000
Bi-207 (83)	0.01	5,000
Bi-210 (83)	0.01	600
Cd-109 (48)	0.01	1,000
Cd-113 (48)	0.01	80
Ca-45 (20)	0.01	20,000
Cf-252 (98)	0.001	9(20mg)
C-14 (6)**	0.01	50,000
Ce-141 (58)	0.01	10,000
Ce-144 (58)	0.01	300
Cs-134 (55)	0.01	2,000
Cs-137 (55)	0.01	2,000
Cl-36 (17)	0.5	100
Cr-51 (24)	0.01	300,000
Co-60 (27)	0.001	5,000
Cu-64 (29)	0.01	200,000
Cm-242 (96)	0.001	60
Cm-243 (96)	0.001	3
Cm-244 (96)	0.001	4
Cm-245 (96)	0.001	2
Eu-152 (63)	0.01	500
Eu-154 (63)	0.01	400
Eu-155 (63)	0.01	3,000
Ge-68 (32)	0.01	2,000
Gd-153 (64)	0.01	5,000
Au-198 (79)	0.01	30,000
Hf-172 (72)	0.01	400
Hf-181 (72)	0.01	7,000
Ho-166 (67)	0.01	100
H-3 (1)	0.5	20,000
I-125 (53)	0.5	10
I-131 (53)	0.5	10

Radioactive Material*	Release Fraction	Quantity (curies)
In-114m (49)	0.01	1,000
Ir-192 (77)	0.001	40,000
Fe-55 (26)	0.01	40,000
Fe-59 (26)	0.01	7,000
Kr-85 (36)	1.0	6,000,000
Pb-210 (82)	0.01	8
Mn-56 (25)	0.01	60,000
Hg-203 (80)	0.01	10,000
Mo-99 (42)	0.01	30,000
Np-237 (93)	0.001	2
Ni-63 (28)	0.01	20,000
Nb-94 (41)	0.01	300
P-32 (15)	0.5	100
P-33 (15)	0.5	1,000
Po-210 (84)	0.01	10
K-42 (19)	0.01	9,000
Pm-145 (61)	0.01	4,000
Pm-147 (61)	0.01	4,000
Ra-226 (88)	0.001	100
Ru-106 (44)	0.01	200
Sm-151 (62)	0.01	4,000
Sc-46 (21)	0.01	3,000
Se-75 (34)	0.01	10,000
Ag110m (47)	0.01	1,000
Na-22 (11)	0.01	9,000
Na-24 (11)	0.01	10,000
Sr-89 (38)	0.01	3,000
Sr-90 (38)	0.01	90
Sr-35 (16)	0.5	900
Tc-99 (43)	0.01	10,000
Tc-99m (43)	0.01	400,000
Te-127m(52)	0.01	5,000
Te-129m(52)	0.01	5,000
Tb-160 (65)	0.01	4,000
Tm-170 (69)	0.01	4,000
Sn-113 (50)	0.01	10,000
Sn-123 (50)	0.01	3,000
Sn-126 (50)	0.01	1,000
Ti-144 (22)	0.01	100

Radioactive Material*	Release Fraction	Quantity (curies)
V-48 (23)	0.01	7,000
Xe-133 (54)	1.0	900,000
Y-91 (39)	0.01	2,000
Zn-65 (30)	0.01	5,000
Zr-93 (40)	0.01	400
Zr-95 (40)	0.01	5,000
Any other ß-γ emitter	0.01	10,000
Mixed fission products	0.01	1,000
Mixed corrosion products	0.01	10,000
Contaminated equipment, ß-γ	0.001	10,000
Irradiated material, any form other than solid non-combustible	0.01	1,000
Irradiated material, solid non-combustible	0.001	10,000
Mixed radioactive waste, ß-γ ***	0.01	1,000
Packaged waste, ß-γ	0.001	10,000
Any other α emitter	0.001	2
Contaminated equipment α	0.0001	20
Packaged waste α ***	0.0001	20

*	For combinations of radionuclides, consideration of the need for an emergency plan is required if the sum of the ratios of the quantity of each radionuclide authorized to the quantity listed for that radionuclide in this paragraph exceeds one. ( ) indicates atomic number.
**	Non CO forms only.
***	Waste packaged in Type B containers does not require an emergency plan.

Category 1 and Category 2 Radioactive Material Thresholds

The terabecquerel (TBq) values are the regulatory standard. The curie (Ci) values specified are obtained by converting from the TBq value. The curie values are provided for practical usefulness only.

Radioactive material	Category 1 (TBq)	Category 1 (Ci)	Category 2 (TBq)	Category 2 (Ci)
Americium-241	60	1,620	0.6	16.2
Americium-241/Be	60	1,620	0.6	16.2
Californium-252	20	540	0.2	5.40
Cobalt-60	30	810	0.3	8.10
Curium-244	50	1,350	0.5	13.5
Cesium-137	100	2,700	1	27.0
Gadolinium-153	1,000	27,000	10	270
Iridium-192	80	2,160	0.8	21.6
Plutonium-238	60	1,620	0.6	16.2
Plutonium-239/Be	60	1,620	0.6	16.2
Promethium-147	40,000	1,080,000	400	10,800
Radium-226	40	1,080	0.4	10.8
Selenium-75	200	5,400	2	54.0
Strontium-90	1,000	27,000	10	270
Thulium-170	20,000	540,000	200	5,400
Ytterbium-169	300	8,100	3	81.0

Note: Calculations Concerning Multiple Sources or Multiple Radionuclides

The "sum of fractions" methodology for evaluating combinations of multiple sources or multiple radionuclides is to be used in determining whether a location meets or exceeds the threshold and is thus subject to the requirements of §289.252(ii) of this title.

I. If multiple sources of the same radionuclide and/or multiple radionuclides are aggregated at a location, the sum of the ratios of the total activity of each of the radionuclides must be determined to verify whether the activity at the location is less than the category 1 or category 2 thresholds in Figure: 25 TAC §289.252(jj)(9), as appropriate. If the calculated sum of the ratios, using the equation below, is greater than or equal to 1.0, then the applicable requirements of §289.252(ii) of this title apply.

II. First determine the total activity for each radionuclide from Figure: 25 TAC §289.252(jj)(9). This is done by adding the activity of each individual source, material in any device, and any loose or bulk material that contains the radionuclide. Then use the equation below to calculate the sum of the ratios by inserting the total activity of the applicable radionuclides in the numerator of the equation and, in the denominator of the equation, the corresponding activity threshold from Figure: 25 TAC §289.252(jj)(9) which is applicable.

Calculations must be performed in metric values (i.e., TBq) and the numerator and denominator values must be in the same units.

R_1 = total activity for radionuclide 1
R_2 = total activity for radionuclide 2
R_N = total activity for radionuclide n
AR_1 = activity threshold for radionuclide 1
AR_2 = activity threshold for radionuclide 2
AR_N = activity threshold for radionuclide n

$$\sum_{1}^{n}\left[\frac{R_1}{AR_1}+\frac{R_2}{AR_2}+\frac{R_n}{AR_n}\right]\geq 1.0$$

Rule Cross Reference	Name of Records/Documents	Time Interval for Keeping Record/Document
(l)(7)(D)	Documentation of all receipts and transfers for the manufacture and commercial distribution of devices	3 years after the date of the event (i.e. receipt or transfer)
(r)(2)(C)	Records of tests and checks of measurements of the radioactivity of radioactive drugs	A minimum of 3 years after when the record was made
(r)(3)(G)	A complete description of any deviation from the manufacturer's instructions when eluting generators or processing radioactive materials with a reagent kit	3 years after the record was made
(s)(4)(G)	Records including the name, address, and point of contact for each general licensee to whom depleted uranium in products or devices is distributed	2 years after the record was made
(x)(10)	Test results and records for generator eluates of molybdenum-99 breakthrough or strontium-82 and strontium-85 contamination	3 years after the record was made
(cc)(6)(B)(v)	All information supporting the report of a transfer of small quantities of source material	1 year after the transfer event is included in a report to the agency, the NRC, or any agreement state
(gg)(7)	Records of information important to the safe and effective decommissioning of the facility	Until the license is terminated by the agency
(ii)(3)(G)(i)	Confirmation of receipt of a notification to the individual of the right to complete, correct and explain any reasons for denial of personnel access authorization	1 year after the date of the notification
(ii)(3)(H)(i)	Documentation regarding the trustworthiness and reliability of individual employees	3 years after the date the individual no longer requires unescorted access to category 1 or category 2 quantities of radioactive material
(ii)(3)(H)(ii)	Copy of the current access authorization program procedures	3 years after the procedure is no longer needed
(ii)(3)(H)(ii)	Superseded material for any portion(s) of the access authorization program procedures that is superseded	3 years after the procedure or any portion(s) of the procedure is superseded

Rule Cross Reference	Name of Records/Documents	Time Interval for Keeping Record/Document
(ii)(3)(H)(iii)	List of persons approved for unescorted access authorization	3 years after the list is superseded or replaced
(ii)(4)(A)(ii)	Certification in writing that each individual employee's identification was properly reviewed and any documents used for the review	3 years after the date an individual granted unescorted access to category 1 or category 2 quantities of radioactive material no longer requires such access, or, for an individual denied access, 3 years from the date the record was made
(ii)(6)(A)(xii)	Written confirmation of an active federal security clearance from the federal agency or employer that granted the clearance or reviewed the criminal history records check of the individual	3 years after the date the individual no longer requires unescorted access to category 1 or category 2 quantities of radioactive material
(ii)(6)(A)(xiii)	Written verification from a service provider licensee for an individual employed by that service provider that it has conducted a background investigation for the individual and approved that individual for unescorted access to category 1 or category 2 quantities of radioactive material	3 years after the date the individual employee no longer requires unescorted access to category 1 or category 2 quantities of radioactive material
(ii)(6)(B)	Written confirmation from a federal agency or employer that reviewed the criminal history records check for an individual who has had a favorably adjudicated U.S. Government criminal history records check within the last 5 years, under a comparable U.S. Government program involving fingerprinting and an FBI identification and criminal history records check provided that he or she makes available the appropriate documentation	3 years after the date the individual no longer requires unescorted access to category 1 or category 2 quantities of radioactive material
(ii)(7)(E)	All fingerprint and criminal history records on an individual (including data indicating no record) received from the FBI, or a copy of these records if the individual's file has been transferred	3 years after the date the individual no longer requires unescorted access to category 1 or category 2 quantities of radioactive material

§289.252 Rule Cross Reference	Name of Records/Documents	Time Interval for Keeping Record/Document
(ii)(8)(C)	Access authorization program review records	3 years after the record was made
(ii)(10)(A)(iv)	Copy of the current security plan	3 years after the record is no longer needed
(ii)(10)(A)(iv)	Copy of superseded material from any portion of the security plan that is superseded	3 years after the record is superseded
(ii)(10)(B)(iii)	Copy of the current implementing procedures	3 years after the procedure is no longer needed
(ii)(10)(B)(iii)	Any superseded portion(s) of the implementing procedures	3 years after the record is superseded
(ii)(10)(C)(iv)	Copies of initial and refresher training	3 years after the date of the training
(ii)(10)(D)(viii)(I)	Copy of the information protection procedures	3 years after the document is no longer needed
(ii)(10)(D)(viii)(II)	List of individuals approved for access to the security plan or implementing procedures	3 years after the document is no longer needed
(ii)(11)(C)	Documentation of the licensee's efforts to coordinate with the LLEA	3 years after the record was made
(ii)(14)(B)	Records on maintenance and testing activities	3 years after the record was made
(ii)(16)(C)	Security program review documentation	3 years after the record was made
(ii)(18)(D)	Verification documentation for any transfer of category 1 or category 2 quantity of radioactive material	3 years after the record was made
(ii)(20)(E)	Documentation, and any revisions thereof, for the preplanning and coordination of shipments of category 1 or category 2 quantities of radioactive material	3 years after the record was made
(ii)(21)(E)	Copy of the advance notification and any revision and cancellation notices for the shipment of category 1 quantities of radioactive material through or across boundaries of a State	3 years after the record was made
(ll)(2)	Documentation of any installation, repair, or maintenance of devices containing sealed sources of radioactive material	5 years after date of service

Figure: 30 TAC Chapter 217--Preamble

Table 1. Application of various design criteria for wastewater treatment systems after the effective date of this rulemaking

Chapter 317	Chapter 317 applies to the design, operation, and maintenance of all unaltered existing infrastructure with plans and specifications approved before August 28, 2008, except for unaltered facilities that were designed and constructed prior to the original effective date of Chapter 317. Chapter 317 applies to all variances that were approved under §217.1(c), as adopted on August 28, 2008, with plans and specifications submitted before March 1, 2009. Chapter 317 was adopted to be effective April 16, 1990 with amendments effective October 3, 1991; March 23, 1994; January 1, 1996; March 3, 1997; and January 6, 2005.
Chapter 217, as adopted on August 28, 2008	Chapter 217, as adopted on August 28, 2008, applies to the design, operation, and maintenance of all unaltered existing infrastructure with plans and specifications approved after August 28, 2008, and before the effective date of the amendments to this chapter that were made during this rulemaking. Chapter 217, as adopted on August 28, 2008, applies to the design, operation, and maintenance of all unaltered existing infrastructure with plans and specifications received, but not yet approved, after August 28, 2008, and before the effective date of the amendments to this chapter that were made during this rulemaking.
These amendments to Chapter 217	These amendments to Chapter 217 apply to the design, operation, installation, and maintenance of any project with plans and specifications received and approved after the effective date of these amendments. These amendments to Chapter 217 apply to infrastructure that was designed under previous criteria, if the infrastructure is being altered or rehabilitated. These amendments to Chapter 217 apply to infrastructure that was designed under previous criteria if the wastewater treatment facility's wastewater permit expires.
Grace period for variances from these amendments to Chapter 217	These amendments to Chapter 217 allow the executive director to grant variances from new requirements added by the amendments to this chapter if the plans and specifications for the project are submitted within 180 days of the effective date of the adopted amendments. For example, if these amendments become effective on January 1, 2016, and the plans and specifications for a project are submitted on January 5, 2016, then any differences between the existing Chapter 217 and the adopted Chapter 217 can potentially be addressed by a variance request.

Figure: 30 TAC §217.55(g)

Table C.3. - Maximum Manhole Spacing

Pipe Diameter *(inches)*	**Maximum Manhole Spacing** *(feet)*
6-15	500
18-30	800
36-48	1,000
54 or larger	2,000

Figure: 30 TAC §217.57(a)(1)(B)(ii)

Equation C.3.

$$T = \frac{(0.085 \times D \times K)}{Q}$$

Where:

T = time for pressure to drop 1.0 pound per square inch gauge in seconds

K = 0.000419×D×L, but not less than 1.0

D = average inside pipe diameter in inches

L = length of pipe line, in feet

Q = rate of loss, 0.0015 cubic feet per minute per square foot internal surface

Figure: 30 TAC §217.57(a)(1)(C)

Table C.4. - Minimum Testing Times for Low-Pressure Air Test

Pipe Diameter *(inches)*	**Minimum Time** *(seconds)*	**Maximum Length for Minimum Time** *(feet)*	**Time for Longer Length** *(seconds/foot)*
6	340	398	0.855
8	454	298	1.520
10	567	239	2.374
12	680	199	3.419
15	850	159	5.342
18	1,020	133	7.693
21	1,190	114	10.471
24	1,360	100	13.676
27	1,530	88	17.309
30	1,700	80	21.369
33	1,870	72	25.856

Figure: 30 TAC §217.60(b)(7)

Table C.5. - Minimum Pump Cycle Times

Pump Horsepower	**Minimum Cycle Times** *(minutes)*
< 50	6
50-100	10
> 100	15

Figure: 30 TAC §217.60(b)(8)

Equation C.4.

$$V = \frac{T \times Q}{4 \times 7.48}$$

Where:

V = Active volume (cubic feet)

Q = Pump capacity (gallons per minute)

T = Cycle time (minutes)

7.48 = Conversion factor (gallons/cubic foot)

Figure: 30 TAC §217.92(f)

Equation D.2.

$$Q = (A \times N) + B$$

Where:

Q = Design flow rate (gallons per minute)

A = Design coefficient, typically 0.5

N = Number of equivalent dwelling units served by the off-site component

B = Safety factor, assumed to be 20.0

Figure: 30 TAC §217.92(f)(1)

Equation D.3.

$$Q = (A_1 \times P) + B$$

Where:

Q = Design flow rate (gallons per minute)

A_1 = Derived from A in Equation D.2. in Figure: 30 TAC §217.92(f), typically 0.15

P = Population to be served

B = Safety factor, assumed to be 20.0

Figure: 30 TAC §217.98(d)

Equation D.6.

$$Q_{vp} = \frac{A \times Q_{max}}{7.5g/cf} + B \times N$$

Where:
Q_{vp} = Minimum vacuum pump capacity
A = Variable based on pipe length
Q_{max} = Station peak flow (gallons per minute)
B = Bleed rate of vacuum valve controller (square feet per minute)
N_v = Number of vacuum valves in system
g/cf = gallons per cubic feet

The value of A must be as follows:

Longest Pipe Length (feet.)	A
0-3,000	5
3,001-5,000	6
5,001-7,000	7
7,001-10,000	8
10,001-12,000	9
12,001-15,000	11

Equation D.7.

$$Q = \frac{V}{PDT} \times \log \frac{H_1}{H_2}$$

Where:
Q = Flow rate of vacuum pump (cubic feet per second)
PDT = Time to reduce head from H_1 to H_2 (seconds)
V = Volume of closed system (cubic feet)
H_1 = Initial absolute pressure head (inches of mercury)
H_2 = Final absolute pressure head (inches of mercury)

Figure: 30 TAC §217.152(g)(3)

Equation F.1.

$$SLR = Q_{peak}/SA$$

Where:

SLR = surface loading rate (gallons per square foot per day)

Q_{peak} = peak flow (gallons per day)

SA = surface area (square feet)

Figure: 30 TAC §217.154(b)(2)

Table F.1. - Design Organic Loading Rates for Sizing Aeration Basins Based on Traditional Design Methods

Process	**Applicable Permit Effluent Sets** *Concentration milligrams per liter (mg/l)*			**Maximum Organic Loading Rate** *Pounds BOD_5/day/1,000 cubic feet (lbs/day/1,000cf)*
	Five-day Biochemical Oxygen Demand (BOD_5)	**Total Suspended Solids (TSS)**	**Ammonia Nitrogen**	
Conventional activated sludge process without nitrification	10	15	NA	45
	20	20	NA	
Conventional activated sludge process with nitrification when reactor temperatures exceed 15° C	10	15	3, 2, or 1	35
Conventional activated sludge process with nitrification when reactor temperatures are 13° to 15° C	10	15	3, 2, or 1	25
Conventional activated sludge process with nitrification when reactor temperatures are 10° to 12° C	10	15	3, 2, or 1	20
Extended aeration basins including oxidation ditches (mean cell residence time over 20 days)	10	15	3, 2, or 1	15

Figure: 30 TAC §217.154(c)(1)

Table F.2. - Maximum Clarifier Weir Overflow Rates Based Upon Traditional Design Methods

Applicable Permit Effluent Sets *concentration milligrams per liter (mg/l)*			**Aeration Basin Organic Loading** *(five-day biochemical oxygen demand,* from Table F.1.	**Process - Treatment Level**	**Maximum Surface Loading Rate at Two-Hour Peak Flow** *(gallons/day/ square foot)*	**Minimum Detention Time at Two-Hour Peak Flow** *(hours)*
BOD_5	**TSS**	**NH_3-N**				
20	20		45	Fixed film - secondary or enhanced secondary	1,200	1.8
10	15					
20	20		45, 35, 25 or 20	Activated sludge - secondary, enhanced secondary, or secondary with nitrification	1,200	1.8
10	15					
10	15	3				
20	20		15	Extended air - secondary	900	2.0
10	15	3	15	Extended aeration - enhanced secondary	800	2.2

Figure: 30 TAC §217.155(a)(3)

Equation F.2.

$$O_2R = \frac{1.2(BOD_5) + 4.3(NH_3 - N)}{BOD_5}$$

Where:

O_2R = Oxygen requirement, pound (lb) O_2/lb five-day biochemical oxygen demand (BOD_5)
BOD_5 = BOD_5 concentration, milligrams per liter (mg/L)
NH_3-N = Ammonia nitrogen, mg/L

Table F.3. - Minimum O_2R for Lower BOD_5 Loadings

Process	O_2R, pounds (lbs) O_2/lb BOD_5
Conventional Activated Sludge Systems that are not Intended to Nitrify	1.2
Conventional Activated Sludge Systems that are Intended to Nitrify and Extended Aeration Systems (including all Oxidation Ditch Treatment Systems)	2.2

Figure: 30 TAC §217.155(b)(1)

Table F.4. - Minimum Airflow Requirements for Diffused Air

Process	Airflow/Five-day biochemical oxygen demand (BOD_5) load *standard cubic feet/day/pound*
Conventional activated sludge systems that are not intended to nitrify	1,800*
Extended aeration systems and all other activated sludge systems that are intended to nitrify, including all oxidation ditch treatment systems	3,200*
*These values were calculated using Equation F.3. in Figure: 30 TAC §217.155(b)(2)(A)(iv) with the following assumptions: a transfer efficiency of 4.0% in wastewater for all diffused air activated sludge processes; a diffuser submergence of 12 feet; a wastewater temperature of 20°C; and the oxygen requirements in Figure: 30 TAC §217.155(a)(3), Table F.3.	

Figure: 30 TAC §217.155(b)(2)(C)

Equation F.4.

$$RAF = \frac{(PPD\ BOD_5) \times (O_2/lb\ BOD_5)}{WOTE \times 0.23 \times 0.075 \times 1440}$$

Where:

RAF = Required Airflow Rate (standard cubic feet per minute (SCFM))

PPD BOD_5 = Influent Organic Load in Pounds per Day of five-day biochemical oxygen demand

0.23 = lb 0_2/lb air @ 20° C

1440 = minutes/day

0.075 = lb air/cubic foot (cf)

WOTE = Wastewater Oxygen Transfer Efficiency (decimal)

If the design inlet temperature is above 24° C, the specific weight of air must be adjusted to the specific weight at the intake temperature.

Figure: 30 TAC §217.164(c)(5)

Equation F.6.

$$V_a = \frac{1,000,000(BODL)(Y)(SRT)}{62.4MLSS}$$

Where:

V_a = Volume of aeration basin, cubic feet

BODL = Design biochemical oxygen demand (BOD) load per day, pounds

Y = yield of solids per unit BOD removed

SRT = required solids retention time, days

MLSS = mixed liquor suspended solids, milligrams per liter

Equation F.7.

$$V_a = \frac{1,000\ (BODL)}{max\ allowable\ lb\ BOD/kcf}$$

Where:

V_a = Volume of aeration basin, cubic feet

BODL = Design BOD load per day, pounds

max allowable lb BOD/kcf = Maximum pounds BOD load/1,000 cubic feet

Figure: 30 TAC §217.164(e)

Equation F.8.

$$A_c = \frac{1,000,000\ Q_p}{OR_p}$$

Where:

A_c = area of the clarifier(s), square feet

Q_p = peak flow, million gallons per day

OR_p = weir overflow rate (gallons per day per square foot) from Table F.9. in Figure 1: 30 TAC §217.164(e)(2)(I)

Figure: 30 TAC §217.164(e)(1)

Equation F.9. Clarifier Volume Based on SWD

$$V_c = A_c\,(minSWD)$$

Where:

V_c, = volume of the clarifier(s), cubic feet, based on minSWD

A_c = Area of the clarifier(s), square feet
minSWD = 10 feet, except as allowed in §217.152(g) of this title (relating to Requirements for Clarifiers)

Equation F.10. Clarifier Volume Based On Minimum Detention Time

$$V_c = \frac{(Q_p / 24)(minDT)}{(7.48)}$$

Where:

V_c, = volume of the clarifier(s), cubic feet, based on minDT

Q_p = peak flow, gallons per day

minDT = minimum detention time (hours) from Table F.2. in Figure: 30 TAC §217.154(c)(1) of this title (relating to Aeration Basin and Clarifier Sizing--Traditional Design)

Figure: 30 TAC §217.164(e)(2)(A)

Equation F.11. Clarifier Area Based on Design Flow

$$A_c = \frac{Q_d}{OR_{T9}}$$

Where:

A_c = clarifier area (square feet (sf)) based on max 30 day flow

Q_d = design flow (gallons per day)

OR_{T9} = weir overflow rate for selected underflow rate and mixed liquor suspended solids (MLSS) (gallons per day per square foot (gpd/sf)) from Table F.9. in Figure 1: 30 TAC §217.164(e)(2)(I)

Equation F.12. Clarifier Area Based on Peak Flow

$$A_c = \frac{Q_p}{OR_{T10}}$$

Where:

$A_{c,}$ = clarifier area (sf), based on peak flow

Q_p = peak flow, million gallons per day

OR_{T10} = weir overflow rate for selected MLSS (gpd/sf) from Table F.10. in Figure 2: 30 TAC §217.164(e)(2)(I)

Figure: 30 TAC §217.164(e)(2)(C)

Equation F.13.

$$MLSS_{pf} = \frac{UR_{T11} * RSSS_{T11}}{OR_{pf} + UR_{T11}}$$

Where:

UR_{T11} = Underflow rate (UR) (gallons per day per square foot (gpd/sf)) from Table F.11 in Figure 3: 30 TAC §217.164(e)(2)(I)

OR_{pf} = Weir overflow rate at peak flow (gpd/sf)

$MLSS_{pf}$ = Diluted mixed liquor suspended solids during peak flow (milligrams per liter (mg/l))

$RSSS_{T11}$ = Maximum return sludge concentration for the selected UR (mg/l) from Table F.11. in Figure 3: 30 TAC §217.164(e)(2)(I)

Figure: 30 TAC §217.164(e)(2)(D)

Equation F.14.

$$SBD = \frac{V_a(MLSS_{av} - MLSS_{pf})}{(A_c BKSS)} + 1.0$$

Where:

SBD = Sludge Blanket Depth (feet)

V_a = Volume of aeration basins (cubic feet)

A_c = Area of clarifier (square feet)

$MLSS_{pf}$ = Diluted MLSS during peak flow (milligrams per liter (mg/l))

$MLSS_{av}$ = Diluted MLSS during average flow (mg/l)

BKSS = Blanket concentration at the selected underflow rate (mg/l) from Table F.11. in Figure 3: 30 TAC §217.164(e)(2)(I)

1.0 = Assumed sludge blanket depth during design flow conditions (feet)

Figure: 30 TAC §217.164(e)(2)(E)(iii)

Equation F.15.

$$SWD_{DT} = \frac{OR_p(DT)}{180}$$

Where:

OR_p = Weir overflow rate at peak flow (gallons per day per square foot)

DT = Detention time, hours

SWD_{DT} = Side water depth based on detention time, feet

Figure: 30 TAC §217.164(e)(2)(F)

Equation F.16.

$$V_c = A_c(SWD)$$

Where:

V_c = Volume of Clarifier, (cubic feet)

A_c = Area of the Clarifier, (square feet)

SWD = Side Water Depth determined in subparagraph (E) of this paragraph, (feet)

Figure: 30 TAC §217.164(e)(2)(G)(i)

Equation F.17.

$$OR_{T10} = 5053.8(1 - fv/100)^{3.83} \text{ gpd/sf}$$

Where:

OR_{T10} = Settling velocity (gallons per day per square foot) of Table F.10. in Figure 2: 30 TAC §217.164(e)(2)(I)

fv = Floc Volume (percent) = SVI(MLSS)/10,000 SVI (ml/g), MLSS (mg/l)

Figure: 30 TAC §217.164(e)(2)(G)(ii)

Equation F.18.

$$OR_{T10} = 9003610(fv^{-2.56})gpd/sf$$

Where:

OR_{T10} = Settling velocity (gallons per day per square foot) of Table F.10. in Figure 2: 30 TAC §217.164(e)(2)(I)

fv = Floc Volume (percent) = SVI(MLSS)/10,000 SVI (ml/g), MLSS (mg/l)

Figure: 30 TAC §217.164(e)(2)(H)

Equation F.19.

$$RSSS_m = \frac{10170000(UR^{-0.391})}{SVI}$$

Where:

$RSSS_m$ = Return Sludge Suspended Solids (milligrams per liter)

UR = Underflow Rate (gallons per day per square foot)

SVI = Sludge Volume Index (ml/g)

Figure 1: 30 TAC §217.164(e)(2)(I)

Table F.9. - Clarifier Loading Rates

Allowable surface loading rates for given underflow rates with no provisions for sludge storage in the clarifier **OR** The maximum surface loading rate at the design flow for clarifiers designed to store solids during peak events					
MLSS	**Underflow Rate (gpd/sf)**				
mg/l	***200***	***250***	***300***	***350***	***400***
2,000	1,081	1,218	1,340	1,452	1,554
2,100	1,020	1,148	1,262	1,366	1,461
2,200	965	1,084	1,191	1,288	1,377
2,300	914	1,026	1,126	1,217	1,299
2,400	868	973	1,067	1,151	1,229
2,500	825	924	1,012	1,091	1,163
2,600	786	879	962	1,036	1,103
2,700	749	837	915	985	1,048
2,800	715	798	872	937	996
2,900	684	762	831	893	948
3,000	654	729	793	851	903
3,100	627	697	758	812	861
3,200	601	667	725	776	821
3,300	577	640	694	742	784
3,400	554	613	665	710	750
3,500	532	589	637	680	717
3,750	483	533	575	611	642
4,000	441	484	520	551	577
4,250	403	441	472	498	520
4,500	369	402	429	451	469
4,750	340	368	391	409	423
5,000	313	337	356	371	382

Figure 2: 30 TAC §217.164(e)(2)(I)

Table F.10. - Settling Velocities

Maximum allowable clarifier weir overflow rate allowed for clarifiers that are designed to store solids SVI=100 *(minimum allowable SVI)*	
MLSS	**Surface Loading Rates**
(mg/l)	**(gpd/sf)**
2,000	2,000
2,150	2,000
2,200	1,952
2,300	1,858
2,400	1,767
2,500	1,680
2,600	1,596
2,700	1,514
2,800	1,437
2,900	1,362
3,000	1,290
3,100	1,220
3,200	1,154
3,300	1,090
3,400	1,029
3,500	971
3,750	836
4,000	715
4,250	611
4,500	528
4,750	459
5,000	403

Figure 3: 30 TAC §217.164(e)(2)(I)

Table F.11. - Values for Use in Determining Sludge Storage Requirements

Underflow (gpd/sf)	200	250	300	350	400
RSSS maximum (mg/l)	12,813	11,743	10,935	10,295	9,771
Blanket concentration (mg/l)	7,816	7,163	6,670	6,280	5,961
Blanket (lb/cf)	0.488	0.447	0.416	0.392	0.372

Figure: 30 TAC §217.182(g)(4)

Equation G.1.

$$SK = \frac{(q + r) \times (1000mm/m)}{(a) \times (n) \times (60)}$$

Where:

SK = dosing intensity, millimeter (mm)/pass of an arm

q = influent flow/filter top surface area, in cubic meters (m^3)/square meter (m^2)/hour

r = recycle flow/filter top surface area, m^3/m^2/hour

a = number of arms

n = revolutions per minute

Figure: 30 TAC §217.182(n)(5)

Equation G.2.

$$MAFR=\frac{(R_A)\times(L)\times(P_F)}{1440\min/day}$$

Where:

MAFR = Minimum airflow rate, scfm
R_A = Aeration rate, scf/lb, Table G.3.
L = Loading rate, lb/day, Table G.3.
P_F = Loading peaking factor

Table G.3. - Aeration Rate and Loading Rate Factors

Filter Application	**R_A (scf/lb BOD_5)**	**L (lb BOD_5/1000 cf/day) Loading on the filter**
Roughing Filter at 75-200 lb BOD_5/1000 cf/day	1080	BOD_5
Secondary Treatment Filter at 25-50 lb BOD_5/1000 cf/day	1200	BOD_5
Combined or Tertiary Filter	2400	1.25 * BOD_5 + 4.6 * total Kjeldahl nitrogen (TKN)

Figure: 30 TAC §217.206(d)

Equation H.1.

$$E = 1 - \frac{1}{1+K\left(\frac{V}{Q}\right)}$$

Where:

E = fraction of five-day biochemical oxygen demand removed in aerated lagoon

K = first order removal rate constant, day^{-1}

V = aeration basin volume, million gallons

Q = design influent wastewater flow rate, million gallons per day.

Figure: 30 TAC §217.206(d)(2)

Equation H.2.

$$K_T = K_{20} \times 1.06^{T-20°C}$$

Where:

K_T = the lowest average water temperature during any 30-day period.

K_{20} = K value at 20°C

T = lowest average water temperature (°C) expected during any 30-day period

Figure: 30 TAC §217.210(i)(2)

Equation H.3.

$$C_0 = C^* + (C_i - C^*) \exp^{-\frac{Ka}{0.0365Q}}$$

Where:
C_i = influent five-day biochemical oxygen demand (BOD_5) concentration, milligrams per liter (mg/l)

C_o = target effluent BOD_5 concentration, mg/l

C* = wetland background limit, mg/l
(for total suspended solids (TSS), C* = 5.1 = 0.16C_i)
(for BOD_5, C* = 3.5+ 0.053 C_i)

K = first-order areal rate constant:
(34 meters/year (m/yr)) @ 20°C for BOD_5)

a = is required wetland area, hectare (1,000 m/yr @ 20° C for TSS) (active treatment area, not including dike, buffers, etc.)

Q = design flow in cubic meters per day

Figure 1: 30 TAC §217.211(e)(3)(B)

Equation H.4. Darcy's Law.

$$Q = K_s \times A \times S$$

Where:

Q = Design flow (gallons/day)

K_S = Media hydraulic conductivity (gallons/square foot/day)

(see Figure 2: 30 TAC §217.211(e)(3)(B), Table H.1.)

S = Hydraulic gradient (foot/foot)

A = Cross sectional area perpendicular to the flow (square feet)

Figure 2: 30 TAC §217.211(e)(3)(B)

Table H.1. - Typical Media Characteristics

Media	**Effective Size** *(inches)*	**Porosity** *(%)*	**Hydraulic Conductivity** *(gallons/square foot/day)*
Fine Gravel	5/8	38	185,000
Medium Gravel	1.25	40	250,000
Coarse Rock	5.0	45	2,500,000

Figure: 30 TAC §217.211(g)(2)

Equation H.5.

$$C_0 = C^* + (C_i - C^*) \exp^{-\frac{Ka}{0.0365Q}}$$

Where:

C_i = influent five-day biochemical oxygen demand (BOD_5) concentration, milligram per liter (mg/l)

C_o = target effluent BOD_5 concentration, mg/l

C^* = wetland background limit, mg/l
(for total suspended solids (TSS) $C^* = 7.8 + 0.063C_i$)
(for BOD_5, $C^* = 3.5 + 0.053C_i$)

K = first-order areal rate constant:
(180 meters per year (m/yr) @ 20° C for BOD_5)
(3,000 m/yr @ 20° C for TSS)

a = is required wetland area, hectare (active treatment area, not including dike, buffers, etc.)

Q = design flow in cubic meters per day

Figure: 30 TAC §217.250(e)(2)(A)(ii)

Table J.3. - Surface Area Requirements for Sludge Drying Beds

Stabilization Process	**Pounds of Digested Dry Solids** ***per square foot per year***
Anaerobic Digestion	20.0
Aerobic Digestion	15.0

Figure: 30 TAC §217.250(e)(4)(A)

Table J.4. - Filtration Rates

Type of Treatment	**Pounds of Dry Solids** ***per square foot per hour (minimum-maximum)***
Primary	4-6
Primary and Trickling Filter	3-5
Primary and Activated Sludge	3-4

Figure: 30 TAC §217.272(a)

Equation K.1.

$$PPD = Q \times D \times 8.34$$

Where:

PPD = Pounds per day of chlorine or sulfur dioxide required for treatment

Q = Peak two hour flow (millions of gallons per day)

D = chlorine concentration from Table K.1. in Figure: 30 TAC §217.272(b), or sulfur dioxide dosage needed to dechlorinate the expected chlorine residual

8.34 = conversion factor

Figure: 30 TAC §217.272(b)

Table K.1. - Minimum Design Chlorine Concentration Needed for Disinfection

Type of Effluent	**Chlorine Concentration** *milligrams per liter (mg/l)*
Primary	15
Fixed Film	10
Activated Sludge	8
Tertiary Filtration Effluent	6
Nitrified Effluent	6