

5. PRODUCTION, IMPORT/EXPORT, USE, AND DISPOSAL

5.1 PRODUCTION

TRI information is available in the TRI database on facilities that manufacture or process vanadium (except when contained in an alloy) and vanadium compounds for Release Year 2009, in accordance with Section 313 of the Emergency Planning and Community Right-to-Know Act (Title III of the Superfund Amendments and Reauthorization Act of 1986) (TRI09 2011).

Seven U.S. firms produced ferrovanadium, vanadium pentoxide, vanadium metal, and vanadium-bearing chemicals or specialty alloys by processing materials such as petroleum residues, spent catalysts, utility ash, and vanadium-bearing pig iron slag (USGS 2012).

Vanadium occurs in uranium-bearing minerals of Colorado, in the copper, lead, and zinc vanadates of Africa, and with certain phosphatic shales and phosphate rocks in the western United States. Commercial production from petroleum ash holds promise as an important source of vanadium. It is a constituent of titaniferous magnetites that are widely distributed in Russia, South Africa, Finland, People's Republic of China, eastern and western United States, and Australia. The vanadium deposits from sulfide and vanadate ores in the Peruvian Andes have been depleted. Most reserves are in deposits where vanadium would be a by-product or co-product with other minerals, including phosphate, titanium, iron, and petroleum (Baroch 2006). High-purity ductile vanadium can be obtained by reduction of vanadium chloride with magnesium or with magnesium-sodium mixtures. Much of the vanadium metal now being produced is made by calcium reduction of V_2O_5 in a pressure vessel (Lide 2008).

World mine production reported for 2011 (in metric tons) was: China, 23,000; Russia, 15,000; South Africa, 19,000; and other countries, 1,500, or about 60,000 metric tons for the world (USGS 2012).

Table 5-1 lists the facilities in each state that manufacture or process vanadium (except when contained in an alloy), the intended use, and the range of maximum amounts of this material that are stored on site. Table 5-2 lists the facilities in each state that manufacture or process vanadium compounds, the intended use, and the range of maximum amounts of this material that are stored on site. The data listed in Tables 5-1 and 5-2 are derived from the Toxics Release Inventory (TRI09 2011). Only certain types of facilities were required to report (EPA 2005b). Therefore, this is not an exhaustive list.

Current U.S. manufacturers of vanadium and selected vanadium compounds are given in Table 5-3.

5. PRODUCTION, IMPORT/EXPORT, USE, AND DISPOSAL

Table 5-1. Facilities that Produce, Process, or Use Vanadium (Except When Contained in an Alloy)

State ^a	Number of facilities	Minimum amount on site in pounds ^b	Maximum amount on site in pounds ^b	Activities and uses ^c
AL	7	100	49,999,999	1, 2, 3, 5, 7, 12, 13, 14
AR	6	0	99,999	1, 2, 3, 5, 8, 12, 13, 14
AZ	6	10,000	9,999,999	1, 2, 3, 4, 5, 6, 12, 13, 14
CA	12	0	999,999	1, 2, 3, 5, 6, 8, 9, 10, 12, 13, 14
CT	2	10,000	999,999	1, 4, 5, 9, 12
FL	8	0	999,999	1, 4, 5, 9, 10, 12, 13, 14
GA	1	1,000,000	9,999,999	1, 11, 13
ID	5	10,000	999,999	1, 2, 3, 5, 10, 12
IL	11	0	999,999	1, 5, 7, 9, 12, 13, 14
IN	4	0	999,999	8, 10, 12, 14
KS	5	100	49,999,999	1, 5, 11, 12, 14
KY	6	0	99,999	1, 5, 7, 8, 11, 12
LA	8	0	999,999	1, 2, 3, 6, 7, 10, 12, 13, 14
MD	3	0	99,999	1, 5
MI	3	1,000	99,999	2, 5, 7, 8, 11, 14
MO	1	1,000	9,999	12
MS	7	10,000	999,999	1, 2, 3, 4, 7, 8, 10, 11, 12
NC	2	1,000	999,999	8
ND	1	100,000	999,999	1, 5, 12
NE	3	10,000	99,999	1, 3, 4, 5, 9, 12, 13
NH	1	0	0	0
NJ	1	10,000	99,999	2, 13
NM	2	10,000	9,999,999	12
NV	1	10,000	99,999	2, 3, 12
NY	3	100	999,999	1, 5, 6
OH	16	0	9,999,999	1, 3, 4, 5, 7, 8, 11, 12, 13, 14
OK	2	10,000	99,999	1, 5, 11, 14
OR	1	10,000	99,999	12
PA	11	0	999,999	1, 2, 3, 4, 5, 6, 7, 8, 12, 13, 14
PR	3	0	99,999	1, 5, 11
SC	10	0	999,999	1, 3, 4, 5, 6, 9, 12, 13
TN	7	100	99,999	1, 2, 3, 5, 8, 9, 13, 14
TX	32	0	49,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
UT	1	10,000	99,999	12
VA	3	0	99,999	1, 2, 5, 12, 13, 14
WA	1	0	0	0
WI	1	1,000	9,999	7, 8

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Table 5-1. Facilities that Produce, Process, or Use Vanadium (Except When Contained in an Alloy)

State ^a	Number of facilities	Minimum amount on site in pounds ^b	Maximum amount on site in pounds ^b	Activities and uses ^c
WV	2	1,000	99,999	10, 12
WY	3	10,000	99,999	1, 10, 12, 13

^aPost office state abbreviations used.

^bAmounts on site reported by facilities in each state.

^cActivities/Uses:

- | | | |
|--------------------------|--------------------------|-----------------------------|
| 1. Produce | 6. Impurity | 11. Chemical Processing Aid |
| 2. Import | 7. Reactant | 12. Manufacturing Aid |
| 3. Onsite use/processing | 8. Formulation Component | 13. Ancillary/Other Uses |
| 4. Sale/Distribution | 9. Article Component | 14. Process Impurity |
| 5. Byproduct | 10. Repackaging | |

Source: TRI09 2011 (Data are from 2009)

5. PRODUCTION, IMPORT/EXPORT, USE, AND DISPOSAL

Table 5-2. Facilities that Produce, Process, or Use Vanadium Compounds

State ^a	Number of facilities	Minimum amount on site in pounds ^b	Maximum amount on site in pounds ^b	Activities and uses ^c
AK	1	10,000	99,999	1, 5, 12, 13, 14
AL	29	0	999,999	1, 3, 4, 5, 7, 8, 9, 12, 13, 14
AR	17	0	999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14
AZ	23	100	99,999,999	1, 3, 4, 5, 6, 9, 10, 11, 12, 13, 14
CA	36	0	49,999,999	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14
CO	26	100	999,999	1, 4, 5, 9, 12, 13, 14
CT	5	100	9,999	1, 4, 5, 9, 12, 13
DE	13	0	999,999	1, 2, 3, 5, 9, 10, 12, 13, 14
FL	58	0	9,999,999	1, 2, 3, 4, 5, 8, 9, 10, 11, 12, 13, 14
GA	32	0	49,999,999	1, 3, 4, 5, 7, 9, 10, 12, 13, 14
HI	1	100	999	1, 5
IA	15	0	999,999	1, 3, 4, 5, 9, 12, 13, 14
ID	13	0	49,999,999	1, 2, 3, 5, 6, 10, 12, 14
IL	53	0	999,999	1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
IN	61	0	9,999,999	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14
KS	23	0	999,999	1, 3, 4, 5, 8, 9, 10, 12, 13, 14
KY	30	0	9,999,999	1, 2, 3, 4, 5, 7, 8, 9, 10, 12, 13, 14
LA	61	0	9,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
MA	12	1,000	99,999	1, 2, 5, 9, 11, 12, 13, 14
MD	19	0	999,999	1, 3, 4, 5, 6, 7, 9, 12, 13, 14
ME	7	0	99,999	1, 5, 12, 13
MI	40	0	499,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 12, 13, 14
MN	12	100	999,999	1, 2, 3, 4, 5, 7, 8, 9, 10, 12, 13, 14
MO	23	0	999,999	1, 3, 5, 9, 10, 12, 13, 14
MS	17	0	9,999,999	1, 2, 3, 4, 5, 8, 9, 10, 13, 14
MT	6	100	999,999	1, 5, 9, 10, 12, 14
NC	39	0	9,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 12, 13, 14
ND	7	10,000	999,999	1, 5, 9, 12, 13, 14
NE	11	1,000	999,999	1, 3, 4, 5, 9, 12, 13
NH	7	0	999,999	1, 5, 9, 12
NJ	24	100	999,999	1, 2, 3, 4, 5, 6, 7, 9, 10, 12, 13, 14
NM	9	1,000	999,999	1, 3, 4, 5, 9, 12, 13, 14
NV	23	0	499,999,999	1, 2, 3, 5, 6, 9, 10, 12, 13, 14
NY	23	0	999,999	1, 2, 3, 4, 5, 6, 7, 9, 12, 13, 14
OH	53	0	9,999,999	1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
OK	18	0	99,999	1, 2, 3, 4, 5, 8, 9, 10, 11, 12, 13, 14
OR	3	1,000	99,999	1, 3, 4, 5, 9, 14
PA	66	0	9,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14

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Table 5-2. Facilities that Produce, Process, or Use Vanadium Compounds

State ^a	Number of facilities	Minimum amount on site in pounds ^b	Maximum amount on site in pounds ^b	Activities and uses ^c
PR	10	0	99,999	1, 2, 5, 10, 13
SC	24	0	9,999,999	1, 3, 4, 5, 7, 8, 9, 12, 13, 14
SD	2	10,000	99,999	1, 5, 9, 13, 14
TN	32	0	9,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14
TX	85	0	499,999,999	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14
UT	27	100	49,999,999	1, 2, 3, 4, 5, 7, 9, 10, 11, 12, 13, 14
VA	22	0	999,999	1, 3, 4, 5, 8, 9, 10, 12, 13, 14
VI	1	100,000	999,999	10, 14
WA	7	1,000	999,999	1, 3, 4, 5, 9, 12, 13, 14
WI	18	0	999,999	1, 3, 4, 5, 7, 9, 12, 13, 14
WV	28	0	999,999	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14
WY	22	0	999,999	1, 4, 5, 9, 11, 12, 13, 14

^aPost office state abbreviations used.

^bAmounts on site reported by facilities in each state.

^cActivities/Uses:

- | | | |
|--------------------------|--------------------------|-----------------------------|
| 1. Produce | 6. Impurity | 11. Chemical Processing Aid |
| 2. Import | 7. Reactant | 12. Manufacturing Aid |
| 3. Onsite use/processing | 8. Formulation Component | 13. Ancillary/Other Uses |
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Source: TRI09 2011 (Data are from 2009)

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Table 5-3. Current U.S. Manufacturers of Vanadium and Selected Vanadium Compounds^a

Company	Location
Vanadium	
International Specialty Alloys	New Castle, Pennsylvania
Vanadium pentoxide	
Denison Mines (USA) Corp.	Blanding, Utah
Gulf Chemical & Metallurgical Corp.	Freeport, Texas
Stratcor, Inc.	Hot Springs, Arizona
Vanadyl sulfate	
The Shepherd Chemical Co.	Cincinnati, Ohio
Shieldalloy Metallurgical Corp.; Specialty Products Division	Cambridge, Ohio
Stratcor, Inc.	Hot Springs, Arizona
Sodium metavanadate	
Denison Mines (USA) Corp.	Blanding, Utah
Shieldalloy Metallurgical Corp.; Specialty Products Division	Cambridge, Ohio
Sodium orthovanadate	
Shieldalloy Metallurgical Corp.; Specialty Products Division	Cambridge, Ohio
Ammonium metavanadate	
Denison Mines (USA) Corp.	Blanding, Utah
Shieldalloy Metallurgical Corp.; Specialty Products Division	Cambridge, Ohio
Stratcor, Inc.	Hot Springs, Arizona

^aStanford Research Institute (SRI 2008), except where otherwise noted. SRI reports production of chemicals produced in commercial quantities (defined as exceeding 5,000 pounds or \$10,000 in value annually) by the companies listed.

^bUSGS 2009b

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5.2 IMPORT/EXPORT

Import sources of ferrovanadium from 2007 to 2010 were 45% from the Republic of Korea, 26% from Canada, 15% from Austria, 12% from Czech Republic, and 2% from other sources. Vanadium pentoxide import sources in this same time period were 46% from Russia, 33% from South Africa, 20% from China, and 1% from other sources (USGS 2012).

5.3 USE

Vanadium is used in producing rust-resistant, spring, and high-speed tool steels. It is an important carbide stabilizer in making steels. About 80% of the vanadium produced is used as ferrovanadium as a steel additive. Vanadium foil is used as a bonding agent in cladding titanium to steel. Vanadium pentoxide is used in ceramics and as a catalyst as well as in producing a superconductive magnet with a field of 175,000 gauss (Lide 2008). Metallurgical use as an alloying agent for iron and steel accounted for approximately 95% of domestic vanadium consumption in 2008 (USGS 2012).

Vanadium, as elemental vanadium or vanadyl sulfate, also may be found in various commercial nutritional supplements and multivitamins (NLM 2009). Vanadyl sulfate and sodium metavanadate have been used in supplements for individuals with diabetes, as well by weight training athletes (Barceloux 1999; IOM 2001; Smith et al. 2008).

5.4 DISPOSAL

Waste material contaminated with vanadium should be disposed of in a manner not hazardous to employees. The disposal method must conform to applicable local, state, and federal regulations and must not constitute a hazard to the surrounding population or environment. Chemical precipitation has been investigated as a possible wastewater treatment technology for vanadium (EPA 1982).

Approximately 1.5×10^6 and 3.3×10^7 pounds of vanadium (except when contained in an alloy) and vanadium compounds, respectively, were reported for on-site disposal and other releases in 2009. On-site disposal or other releases include emissions to the air, discharges to bodies of water, disposal at the facility to land, and disposal in underground injection wells. Approximately 6.2×10^5 and 6.6×10^6 pounds of vanadium (except when contained in an alloy) and vanadium compounds, respectively, were reported for off-site disposal and other releases in 2009. An off-site disposal or other release is a discharge of a

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toxic chemical to the environment that occurs as a result of a facility's transferring a waste containing a TRI chemical off-site for disposal or other release (TRI09 20011). The TRI data should be used with caution because only certain types of facilities are required to report (EPA 2005b). This is not an exhaustive list.

Some tool steel scrap was recycled mainly for its vanadium content, and vanadium was recycled from spent chemical process catalysts; however, these two sources together accounted for only a small percentage (USGS 2012).