RHENIUM

(Data in kilograms of contained rhenium unless otherwise noted)

Domestic Production and Use: During 2021, rhenium-containing products including ammonium perrhenate (APR), metal powder, and perrhenic acid were produced as byproducts from roasting molybdenum concentrates from porphyry copper-molybdenum deposits in Arizona and Montana. U.S. primary production was approximately 9,100 kilograms in 2021, a 4% increase from the previous year. The United States continued to be a leading producer of secondary rhenium, recovering rhenium from nickel-base superalloy scrap, spent oil-refining catalysts, and foundry revert. The major uses of rhenium were in superalloys used in high-temperature turbine engine components and in petroleum-reforming catalysts, representing an estimated 80% and 15%, respectively, of end uses. Bimetallic platinum-rhenium catalysts were used in petroleum reforming for the production of high-octane hydrocarbons, which are used in the production of lead-free gasoline. Rhenium improves the high-temperature (>1,000 degrees Celsius) strength properties of some nickel-base superalloys. Rhenium alloys were used in crucibles, electrical contacts, electromagnets, electron tubes and targets, heating elements, ionization gauges, mass spectrographs, metallic coatings, semiconductors, temperature controls, thermocouples, vacuum tubes, and other applications. The value of rhenium consumed in 2021 was about $35 million as measured by the value of imports of rhenium metal and APR.

Salient Statistics—United States:	**2017**	**2018**	**2019**	**2020**	**2021[e]**
Production[1]	8,200	8,220	8,360	8,830	9,100
Imports for consumption[2]	34,500	39,400	44,300	25,200	23,000
Exports	NA	NA	NA	NA	NA
Consumption, apparent[3]	42,700	47,600	52,600	34,000	32,000
Price, average value, gross weight, dollars per kilogram:[4]					
Metal pellets, 99.99% pure	1,550	1,470	1,300	1,030	980
Ammonium perrhenate	1,530	1,410	1,280	1,130	1,000
Employment, number	Small	Small	Small	Small	Small
Net import reliance[5] as a percentage of apparent consumption	81	83	84	74	72

Recycling: Nickel-base superalloy scrap and scrapped turbine blades and vanes continued to be recycled hydrometallurgically to produce rhenium metal for use in new superalloy melts. The scrapped parts were also processed to generate engine revert—a high-quality, lower cost superalloy meltstock—by an increasing number of companies, mainly in the United States, Canada, Estonia, France, Germany, Japan, Poland, and Russia. Rhenium-containing catalysts were also recycled.

Import Sources (2017–20): Ammonium perrhenate: Kazakhstan, 21%; Canada, 18%; Germany, 16%; Poland, 16%; and other, 29%. Rhenium metal powder: Chile, 84%; Germany, 7%; Canada, 6%; and other, 3%. Total imports: Chile, 51%; Canada, 13%; Kazakhstan, 11%; Japan, 7%; and other, 18%.

Tariff: **Item**	**Number**	**Normal Trade Relations 12–31–21**
Salts of peroxometallic acids, other, ammonium perrhenate	2841.90.2000	3.1% ad valorem.
Rhenium (and other metals), waste and scrap	8112.92.0600	Free.
Rhenium, unwrought and powders	8112.92.5000	3% ad valorem.
Rhenium (and other metals), wrought	8112.99.9000	4% ad valorem.

Depletion Allowance: 14% (domestic and foreign).

Government Stockpile: None.

Events, Trends, and Issues: For the 10th year in a row, rhenium metal and catalytic-grade APR prices decreased. In 2021, the price of catalytic-grade APR averaged $1,000 per kilogram, a 12% decrease from the annual average price in 2020. The rhenium metal pellet price averaged $980 per kilogram in 2021, a 5% decrease from the annual average price in 2020.

In 2021, apparent consumption in the United States decreased by 6% compared with that in 2020. During 2021, the United States continued to rely on imports for much of its supply of rhenium. Canada, Chile, Japan, and Kazakhstan supplied most of the imported rhenium. Imports of APR decreased by 32% in 2021 compared with those in the previous year. Imports of rhenium metal decreased by 6% in 2021 compared with those in the previous year. World rhenium production in 2021 was estimated to be essentially the same as that in 2020.

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The United States and Germany continued to be the leading secondary rhenium producers. Secondary rhenium production also took place in Canada, Estonia, France, Japan, Poland, and Russia. Available information was insufficient to make U.S. secondary production estimates; however, industry sources estimated annual U.S. capacity between 18 and 20 tons of rhenium. Industry sources estimated approximately 25 tons of secondary rhenium was produced worldwide in 2021.

There were no primary rhenium projects in 2021 that were expected to significantly contribute to rhenium availability in the near future. Continued low prices of rhenium as well as the global COVID-19 pandemic continued to cause many rhenium recyclers as well as primary-rhenium production facilities to stop recycling or producing rhenium to focus on a more profitable market. The major aerospace companies were expected to continue testing superalloys that contain one-half the quantity of rhenium used in engine blades as currently designed, as well as testing rhenium-free alloys for other engine components.

On November 9, 2021, a proposed revised U.S. critical minerals list was published in the Federal Register (86 FR 62199). The new list contained 50 individual mineral commodities; proposed changes were the addition of nickel and zinc and the removal of helium, potash, rhenium, strontium, and uranium, which were included in the 2018 critical minerals list.

World Mine Production and Reserves:

	Mine production[6]		Reserves[7]
	2020	2021[e]	
United States	8,830	9,100	400,000
Armenia	260	260	95,000
Chile[8]	30,000	29,000	1,300,000
China	2,500	2,500	NA
Kazakhstan	500	1,000	190,000
Korea, Republic of	2,800	2,800	NA
Poland	9,510	9,500	NA
Russia	NA	NA	310,000
Uzbekistan	4,900	4,900	NA
World total (rounded)	59,300	59,000	Large

World Resources:[7] Most rhenium occurs with molybdenum in porphyry copper deposits. Identified U.S. resources are estimated to be about 7 million kilograms. Rhenium also is associated with copper minerals in sedimentary deposits in Armenia, Kazakhstan, Poland, Russia, and Uzbekistan, where ore is processed for copper recovery and the rhenium-bearing residues are recovered at copper smelters.

Substitutes: Substitutes for rhenium in platinum-rhenium catalysts are continually being evaluated. Iridium and tin have achieved commercial success in one such application. Other metals being evaluated for catalytic use include gallium, germanium, indium, selenium, silicon, tungsten, and vanadium. The use of these and other metals in bimetallic catalysts might decrease rhenium's share of the existing catalyst market; however, this would likely be offset by rhenium-bearing catalysts being considered for use in several proposed gas-to-liquid projects. Materials that can substitute for rhenium in various end uses are as follows: cobalt and tungsten for coatings on copper x-ray targets, rhodium and rhodium-iridium for high-temperature thermocouples, tungsten and platinum-ruthenium for coatings on electrical contacts, and tungsten and tantalum for electron emitters.

[e]Estimated. NA Not available.

[1]Based on 80% recovery of estimated rhenium contained in molybdenum disulfide concentrates. Secondary rhenium production is not included.

[2]Does not include wrought forms or waste and scrap. The rhenium content of ammonium perrhenate is 69.42%.

[3]Defined as production + imports – exports.

[4]Average price per kilogram of rhenium in pellets or catalytic-grade ammonium perrhenate. Source: Argus Media group—Argus Metals International.

[5]Defined as imports – exports.

[6]Estimated amount of rhenium recovered in association with copper and molybdenum production. Secondary rhenium production not included.

[7]See Appendix C for resource and reserve definitions and information concerning data sources.

[8]Estimated rhenium recovered from roaster residues from Belgium, Chile, Mexico, and Peru.