2. RELEVANCE TO PUBLIC HEALTH

2.1 BACKGROUND AND ENVIRONMENTAL EXPOSURES TO TUNGSTEN IN THE UNITED STATES

Tungsten is a naturally occurring element found in some rocks and soils. In nature, tungsten exists in mineral forms, but not as the pure metal. Tungsten is recovered from mineral ores to produce pure tungsten metal or tungsten alloys or compounds. Alloys that contain tungsten and other metals are strong and flexible, resist wear, and conduct electricity well. Tungsten and its alloys are used in products such as light bulb filaments, x-ray tubes, phonographic needles, welding electrodes, gyroscope wheels, counterbalance and fishing weights, darts, and golf clubs. Tungsten is also used in armor-piercing munitions. Tungsten alloy “green” bullets are beginning to replace lead bullets in the United States and other countries. Cemented tungsten carbide, a hard substance used to make grinding wheels and cutting or forming tools, is the most common tungsten compound. Other products that contain tungsten compounds include ceramic pigments and fire retardant fabric coatings and dyes.

Tungsten is released to the atmosphere by windblown dusts and during ore processing, tungsten alloy (hard-metal) fabrication, tungsten carbide production and use, and municipal waste combustion. Tungsten enters waterways through the natural weathering of rocks and soils, by extraction and processing of tungsten, and via deposition of tungsten aerosols or dusts from both natural and anthropogenic sources. The concentration of tungsten in ambient air is <10 ng/m^3. Limited available information indicates that levels of tungsten in food are expected to be low. For example, onions collected from 11 Danish sites contained tungsten at a mean level of 16.7 μg/kg fresh weight. Levels of tungsten are expected to be low in most drinking water supplies in the United States. However, elevated concentrations of tungsten have been observed in tap water samples taken from regions of Nevada where relatively high tungsten levels have been noted in surface water and groundwater. For example, in 2002, a United States Geological Survey (USGS) study reported a mean tungsten concentration of 19.9 μg/L (range, 0.25–337 μg/L) in samples taken from private wells and public water supplies in Churchill County. A CDC study of household water samples from the Churchill County community reported tungsten levels ranging from 0 to 217.3 μg/L. In a follow up study, tungsten levels in the tap water of residents in the community of Yerington, which neighbors Churchill County, were measured at a mean (geometric) concentration of 3.32 μg/L (range, 1.82–6.04 μg/L), compared to a mean concentration of

4.46 µg/L (range, 2.98–7.30 µg/L) for Churchill County residents, indicating that elevated tungsten levels in tap water are not unique to Churchill County.

The general population may be exposed to measurable amounts of tungsten by inhaling airborne tungsten. Tungsten blood and urine levels of 1–6 and 0.085 µg/L, respectively, have been measured in the general public. However, elevated levels of tungsten in the drinking water of some areas indicate potential for significant oral exposure as well. Based on the studies of residents in Churchill County (City of Fallon) and surrounding communities, the mean concentrations of tungsten in urine ranged from 0.48 to 1.19 µg/L and appeared to correlate with the concentrations of tungsten in tap water. Individuals who work in manufacturing, fabricating, and reclaiming industries, especially individuals using hard metal materials or tungsten carbide machining tools, may be exposed to higher levels of tungsten or tungsten compounds than the general population. Occupational exposure is primarily via inhalation of dust particles of elemental (metallic) tungsten and/or its compounds.

2.2 SUMMARY OF HEALTH EFFECTS

Pulmonary fibrosis, memory and sensory deficits, and increased mortality due to lung cancer have been attributed to occupational exposure to dusts generated in the hard metal industry. Hard metal is an alloy or encapsulated mixture that is composed of tungsten or tungsten carbide and cobalt (primarily, although the alloys may also contain yttrium, thorium, copper, nickel, iron, or molybdenum). Based on the presence of tungsten oxide fibers in air samples taken at some hard metal facilities and demonstrations that tungsten oxide fibers are capable of generating hydroxyl radicals in human lung cells in vitro, it has been suggested that tungsten oxide fibers may contribute to the development of pulmonary fibrosis in hard metal workers. Historically, the respiratory and neurological effects observed in hard metal workers have been attributed to cobalt, not tungsten. Available epidemiological data do not implicate tungsten as a source of respiratory or neurological effects observed in hard metal workers. Refer to the toxicological profile for cobalt for a discussion of health effects associated with exposure to dusts in the hard metal industry.

Limited reports associate tungsten exposure with reproductive and developmental effects such as decreased sperm motility, increased embryotoxicity, and delayed fetal skeletal ossification in animals. However, more detailed accounts of tungsten-induced reproductive and developmental toxicity were not located. Tungsten has been observed to cross the placental barrier and enter the fetus. Dermal or ocular exposure to tungsten may result in localized irritation. No adequate animal data are available to assess the carcinogenic potential of tungsten or tungsten compounds. In one recent study, intramuscularly-implanted tungsten alloy (91.1% tungsten, 6.0% nickel, and 2.9% cobalt) was shown to rapidly cause aggressive tumors in rats. However, since both nickel and cobalt are known to cause tumors following intramuscular injection in rats, the carcinogenic role of tungsten itself was not determined. Results of *in vitro* testing by one group of investigators indicate the potential for synergistic effects following exposure to tungsten alloys such as tungsten-cobalt-nickel and tungsten-nickel-iron. Tungsten has recently been nominated to the National Toxicology Program (NTP) for toxicological characterization, which includes carcinogenicity testing.

2.3 MINIMAL RISK LEVELS

Inhalation MRLs

No inhalation MRLs were derived for tungsten or tungsten compounds since adequate data were not available for this route of exposure.

Oral MRLs

No oral MRLs were derived for tungsten or tungsten compounds due to a lack of availability of data for this route of exposure. This finding will be evaluated based on a review of several recently translated foreign articles to determine if the data they contain and the scientific method under which they were developed are adequate for MRL derivation.