Beryllium

Where does it come from? How is it present in mining?
Beryllium is a hard, very light, silvery white metal that can be associated with underground mining. Beryllium can be present in coal, oil, mineral rocks, volcanic dust, and soil. Beryllium is mined from two types of mineral rocks: betrandrite and beryl. These minerals are mostly found in found in granite and pegmatites. Other ores that may contain beryllium include phenacite and chrysoberyl. In mining, beryllium can be present in ores that are extracted for other minerals.

What are the primary health effects from exposure to Beryllium?
During the mining process small particles containing beryllium can be inhaled or they can settle on the skin. Long-term inhalation of beryllium can cause lung cancer. Berylliosis (Chronic Beryllium Disease) can occur from exposures as short as a few months or over 30 years and consists of an immune reaction to the metal. Common symptoms include: persistent coughing, difficulty breathing with excretion, fatigue, chest and joint pain, weight loss and fevers. This disease is incurable. Breathing really high concentrations of beryllium (>100 $\mu g/m^3$) even for a short period of time can cause Acute Beryllium Disease, which can include: pneumonitis, difficulty breathing, cough, chest pain and even death. Inhalation of beryllium can also cause: weight loss, fatigue, weakness and irritation of the eyes, nose and respiratory tract. Dermal exposure can result in skin sensitivity and allergies.

What are the occupational exposure limits for Beryllium?
Title 30 CFR §§ 57.5005 states that exposure shall not exceed the Threshold Limit Values Adopted by the American Conference of Governmental Industrial Hygienists in 1973. The Threshold Limit Values for beryllium are 0.002 mg/m^3 (2 $\mu g/m^3$) and 0.025 mg/m^3 (25 $\mu g/m^3$) averaged over 8 hours and 5 minutes, respectively.

While not required by the Mining Safety and Health Administration, it is highly recommended to comply with the most current recommended airborne concentration standards. The 2011 ACGIH TLV for beryllium is 0.00005 mg/m^3 (I) for an 8-hour time-weighted average with a "skin" notation. The designation of "I" indicates that the TLV is limited to the inhalable fraction of the metal dust or fume. The designation of "skin" indicates a danger for skin absorption adding to the internal dose.

How often shall I complete exposure monitoring for Beryllium?
30 CFR Part 56.5002 requires that dust, mist, and fume surveys be conducted *as frequently as necessary* to determine the adequacy of control measures. It is standard practice to sample initially (called a baseline evaluation) to determine potential exposure concentrations. Routine or periodic monitoring (usually annually) is also recommended. Sampling may need to be done more often if the tasks change, if engineering controls change, or if sampling results are above the "action limit" which, for most chemicals, is defined as 50% (or half) of the TLV.

How do I measure potential exposures to Beryllium?
To assess beryllium exposures you should conduct both air sampling and wipe sampling. Air sampling can be completed for the entire shift to compare with the 8-hr limit or for 30 minutes to compare with the short-term exposure limit. Consecutive short-term exposures could be completed to obtain the time-weighted full shift exposure.

A sampling pump is calibrated to 1.7 liter per minute. A 37 mm diameter mixed cellulose ester (MCE) filter with a 0.8 µm pore size is placed in a cassette and connected to the pump. The pump is placed on the worker with the cassette in their breathing zone for the appropriate duration. Upon completion the filter should be set to certified laboratory for analysis. At least one blank filter should also be sent. This filter should go through all the same processes except that the pump is not turned on.

Once the laboratory provides you with the mass of beryllium measured on the filter, you can calculate the air concentration as:

$$C = \frac{M}{Q \times T}$$

where C is the concentration of beryllium in mg/m^3, M is the mass of beryllium measured on the filter in mg, Q is the pump flow rate in liters per minute and T is the total time of sampling in minutes. Note that many laboratories will loan you the necessary equipment to obtain the samples and provide you with the appropriate filters.
Wipes samples should be completed while wearing clean disposable gloves to avoid contamination. A piece of Whatman filter paper (41 or 42) or smear tabs moistened with distilled water is used to wipe a 10 cm x 10 cm area. Then the paper is folded in half and transported in a plastic bag or jar to the laboratory for analysis. A clean piece of filter paper should also be submitted to the laboratory as a blank.

Certified laboratories that can assist with measuring Beryllium:
Galson http://www.galsonlabs.com/
Analytics Corporation http://www.analyticscorp.com/

How do I control exposures to Beryllium?
Ventilation is recommended for controlling dust exposures including for beryllium. Appropriate administrative controls should also be used to ensure adequate maintenance for the ventilation system and further dust suppression. It is recommended that a NIOSH approved respirator (APF=10,000) be used at exposures greater than 0.0005 mg/m^3.

References:
MSHA. 2007. Metal Nonmetal Health Inspection Procedures Handbook. PH06-IV-1(1). http://www.msha.gov/readroom/handbook/PH09-IV-1.pdf
MSHA Code of Federal Regulations (http://www.msha.gov/30cfr/0.0.htm).
Mineral Information Institute. Common Minerals and Their Uses. http://www.mii.org/commonminerals.html
Patnaik, P. 2007. A comprehensive guide to the hazardous properties of chemical substances. New Jersey: Wiley & Sons.
OSHA Safety and Health Topics: Beryllium http://www.osha.gov/SLTC/beryllium/index.html