APPENDIX 1

Description of the Health Hazards and Recommended Exposure Limits for the Eleven Health-Related Agents

Arsenic

Inhalation, ingestion, or dermal exposure of workers to inorganic arsenic has reportedly caused peripheral nerve inflammation (neuritis) and degeneration (neuropathy), reduced peripheral circulation, anemia, increased mortality due to cardiovascular failure, and cancer of the skin, lungs, and lymphatic system. The OSHA PEL for arsenic is 10 micrograms/cubic meter of air.

Arsenic is considered an occupational carcinogen by NIOSH. The NIOSH policy regarding occupational carcinogens has changed from a recommend exposure limit (REL) of "lower feasible concentration". The new NIOSH policy for carcinogens is described in the following paragraph (This policy applies to all workplace hazards, including carcinogens):

For the past 20 plus years, NIOSH has subscribed to a carcinogen policy that was published in 1976 by Edward J. Fairchild, II, Associate Director for Cincinnati Operations, which called for "no detectable exposure levels for proven carcinogenic substances [New York Academy of Sciences Annals 1976]." This was in response to a generic OSHA rulemaking on carcinogens.

Because of advances in science and in approaches to risk assessment and risk management, NIOSH has in more recent years adopted a more inclusive policy. NIOSH RELs will be based on risk evaluations using human or animal health effects data, and on an assessment of what levels can be feasibly achieved by engineering controls and measured by analytical techniques. To the extent feasible, NIOSH will protect not only a no-effect exposure, but also exposure levels at which there may be residual risks.

The effect of this new policy for potential occupational carcinogens will be the development, whenever possible, of quantitative RELs that are based on human and/or animal data, as well as on the consideration of technological feasibility for controlling workplace exposures to the REL. Under the old policy for potential occupational carcinogens, RELs for most carcinogens were non-quantitative values labeled "lowest feasible concentration (LFC)." In 1989, NIOSH adopted several quantitative RELs for carcinogens from OSHA's PEL update. NIOSH will also recommend the complete range of respirators (as determined by the NIOSH Respirator Decision Logic) for carcinogens with quantitative RELs. In this way, respirators will be consistently recommended regardless of whether a substance is a carcinogen or a non-carcinogen.

Beryllium

Inhalation of beryllium may result in rhinitis, tracheobronchitis, pneumonitis, and death due to pulmonary edema or heart failure. Beryllium has been associated with damage to the kidney, liver, spleen and heart, and an increased incidence of lung cancer. The NIOSH REL and OSHA PEL for beryllium are 0.50 and 2.0 micrograms/cubic meter of air, respectively.

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Cadmium

Cadmium dust may cause irritation of the nose and throat, cough, chest pain, sweating, chills, shortness of breath, and weakness. Repeated exposure may cause loss of the sense of smell, ulceration of the nose, shortness of breath, kidney damage, and mild anemia. An increased incidence of prostrate cancer in men has been reported. The OSHA PEL for cadmium is 5.0 micrograms/cubic meter of air. NIOSH does not currently have a recommended exposure limit (REL) for cadmium.

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Chromium

Chromium metal and divalent and trivalent compounds have been associated with dermatitis and allergic skin reaction. The compounds may cause skin ulceration, ulceration in the mucus membranes, and perforations of the nasal septum. Adverse effects on pulmonary functions, including hypersensitivity, have been reported. The NIOSH REL for chromium are both 500 micrograms/cubic meter of air.

Per the "NIOSH Pocket Guide to Chemical Hazards" the OSHA PEL for chromium depends on the valence. The OSHA PEL for chromium metal and insoluble salts is 100 $\mu g/m^3$. The OSHA PEL for chromium (II) and (III) compounds is 500 $\mu g/m^3$. The NIOSH REL for all valences of chromium is 500 $\mu g/m^3$, with the exception of the REL of 1 $\mu g/m^3$ for the hexavelent chromium, which is based on a 10 hour TWA.

Lead

Inhalation or ingestion of inorganic lead has reportedly caused peripheral neuropathy with paralysis of the muscles of the wrists and ankles, encephalopathy, anemia due to decreased red blood cell life and impaired heme synthesis, kidney damage and adverse effects on the reproductive systems of males and females. The NIOSH REL and OSHA PEL for lead are 100 and 50 micrograms/cubic meter of air, respectively.

Manganese

Prolonged or repeated exposure to manganese may effect the nervous system with difficulty in walking, weakness, memory lapse, and unstable emotions. Chronic exposure may effect the respiratory system resulting in pneumonitis and bronchitis. The NIOSH REL for manganese metal, fumes, and compounds is 1,000 micrograms/cubic meter of air. The OSHA PEL for manganese is 5,000 micrograms/cubic meter of air as a ceiling limit.

Nickel

Systemic affects from ingestion or inhalation of low solubility nickel compounds have not been reported. Absorption from the lungs depends on the solubility of the compounds. Occupational exposure to nickel compounds with low solubility, particularly the oxide, has reportedly caused lung cancer. Evidence suggests that soluble nickel compounds may cause respiratory or gastric cancer. Metallic nickel or nickel compounds are sensitizing. Lung reactions in the form of asthma have been attributed to nickel sensitization. Pneumoconiosis has also been reported. The NIOSH REL and OSHA PEL for nickel are 15 and 1,000 micrograms/cubic meter of air, respectively.

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Silver

Silver and soluble silver compounds may cause discoloration or a blue-gray coloring of the eyes, nose, throat, and skin. The NIOSH REL and OSHA PEL for silver are both 10 micrograms/cubic meter of air.

Titanium Dioxide

The effects of titanium dioxide on the body reveal that the substance is relatively inert, not absorbed readily by the body, and exerts little toxic effects. Animal studies show no fibrous effect from inhalation although an increase incidence of lung tumors in animals has been reported. NIOSH previously recommended that "occupational exposures to carcinogens be limited to the lowest feasible concentrations". Therefore, for this study, the analytical limit of quantification is used as the NIOSH REL for titanium. The OSHA PEL for titanium is 15,000 micrograms/cubic meter of air.

Titanium dioxide is considered an occupational carcinogen by NIOSH. The NIOSH policy regarding occupational carcinogens has changed from a recommend exposure limit (REL) of "lower feasible concentration". The new NIOSH policy for carcinogens is described in the following paragraph (This policy applies to all workplace hazards, including carcinogens):

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Vanadium

Vanadium dust may cause irritation of the eyes, nose, throat, and also the respiratory tract. It may also cause bronchitis with wheezing and chest pain. Repeated or prolonged exposure may also cause an allergic skin rash. The NIOSH REL and OSHA PEL (Respirable) for vanadium (except vanadium metal and vanadium carbide) are 50 and 500 micrograms/cubic meter of air as ceiling limits, respectively. For the purpose of this study, the OSHA PEL for respirable vanadium was used for total vanadium dust, as there is no PEL for total vanadium dust listed.

Respirable Silica-Quartz

Respirable silica-quartz causes silicosis after chronic exposure. The formation of scattered, rounded or stellate silica-containing nodules of scar tissue in the lungs characterize classical silicosis. It may be slowly progressive, even in the absence of continued exposure. Acute silicosis may occur under conditions of extremely high crystalline quartz dust exposures, particularly when the particle size of the dust is very small. This disease differs from classical silicosis in that it is rapidly progressive with diffuse pulmonary involvement. Animal studies have indicated an increased risk of lung cancer. The NIOSH REL for respirable quartz is 0.05 milligrams/cubic meter of air. The OSHA PEL for respirable quartz is 10 milligrams/cubic meter of air divided by % silica + 2.

Respirable Quartz Airborne Samples:

The following seven of the respirable quartz airborne samples were quantified by primary peak height measurement due to problematical integration data for these samples: (96-4771 garnet G-2B), (96-4795 garnet G-2B), (96-4783 garnet G-2B), (96-4380 garnet G-4A), (96-4774 garnet G-3A), (96-4781 garnet G-3A), and (96-4819 silica sand with dust suppressant SSDS-03). Samples (96-4441 silica sand with dust suppressant SSDS-03) and (96-4537 nickel slag N-01) were analyzed by secondary peak height analysis due to nearby interference of the primary peak.

Total Quartz Bulk Samples:

The following virgin and post bulk samples had interference problems in the primary peak area and were analyzed by peak height measurement of the secondary peak: garnet G-2A, garnet G-2B, specular hematite, and nickel slag N-01. The virgin and post bulk samples of garnet G-2B and nickel slag N-01were also checked microscopically for quartz which identified the samples as non-detectable (<5%, <3%, <3%, and <1%). The garnet virgin bulk samples G-1B and G-4A had interference problems, but were analyzed by long range qualititative scan (5 to 90 degrees two theta). They appeared to have primary and secondary quartz peaks, but showed no other quartz peaks. The virgin and post bulk samples of garnet G-3A and steel grit SG-1A and the post bulk samples of garnet G-1B and garnet G-4A had interference problems in the primary peak area and were checked microscopically for quartz.