

**Senate Democratic Policy Committee Hearing**

**“The Exposure at Qarmat Ali:  
Contractor Misconduct and the Safety of U.S. Troops in Iraq”**

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Good morning, my name is Dr. Max Costa and I am a Professor and Chairman of the Department of Environmental Medicine at New York University (NYU). At NYU, I am in charge of a large department that conducts research and instruction on how chemical and physical agents in our environment injure humans. My area of expertise is heavy metals, such as Hexavalent Chromium, which is present in Sodium Dichromate. I study how these agents cause toxicity and cancer in humans.

As an explanatory note, Sodium Dichromate is a salt that contains two molecules of Hexavalent Chromium ( $\text{Na}_2\text{Cr}_2\text{O}_7$ ) and Hexavalent Chromium is a toxic component of Sodium Dichromate. In my testimony, I will refer to Sodium Dichromate as Hexavalent Chromium, since it is this element of Sodium Dichromate that injures humans. This is also how medical literature commonly refers to the compound.

During my career, I have served on the International Agency for Research on Cancer (IARC) and prepared a monograph which included an assessment of Hexavalent Chromium as a human carcinogen. I have published numerous original research articles and reviews on how Hexavalent Chromium induces toxicity and cancer in humans. My curriculum vitae include over 300 articles that I have published, and most of these are about the toxicity and carcinogenicity of heavy metals. I have also served as an expert witness for the plaintiffs in the Erin Brockovich binding arbitration case in both Hinkley and Kettleman, CA. As an expert witness, I examined the medical records of the

plaintiffs in those cases and determined which of their injuries were caused by Hexavalent Chromium.

### Background and Use of Chromium

Chromium exists in two major forms, the trivalent and the hexavalent form, which differ in toxicity by 500 to 1,000 fold. The reason being that the hexavalent form is like a Trojan horse, given that it looks like a nutrient our body needs and is actively taken up into our cells by transporters. In contrast, the trivalent form is not taken up into cells and is not very toxic. This means that symptoms from exposure to this compound develop over time, sometimes over months, sometimes years, depending on a number of factors, including the level and frequency of exposure.

Unfortunately, of the two of these substances, the hexavalent form has had the most usage in industry. It has been used as a wood preservative, as an antifungal and corrosion inhibitor in water, as an additive in oil drilling mud, in leather tanning, in plating of engine parts and other instruments to prevent them from rusting and to refurbish them, as a color pigment, and in production of stainless steel. Its use in water for cooling towers, which were made from wood, was banned by the United States in the early 1990s and on January 8, 2007, the Environmental Protection Agency (EPA) banned the use of acid copper chromate (ACC), a wood preservative pesticide intended for residential use. Due to its extensive use in the past, Hexavalent Chromium is a major component of most U.S. Superfund toxic waste dump sites.

There were a number of chromate refineries in the U.S. operating in the 1950s and 1960s, but they have been closed due to the number of lung cancers reported in Hexavalent Chromium-exposed workers. In fact, there are probably more

epidemiological studies demonstrating that Hexavalent Chromium causes lung and other types of cancer than any other carcinogen that has been studied. Hexavalent Chromium has been known to be a human carcinogen ever since the late 1800s.

#### Comparison of Hexavalent Chromium to Other Toxic Agents

Hexavalent Chromium is one of the most potent carcinogens known to man. It can produce any type of cancer depending upon genetic susceptibility, quantity and route of exposure. It is important that humans not be exposed to this carcinogen since it can enter the human body by inhalation, ingestion, and also through the skin. In the United States, we have increasingly abandoned the use of Hexavalent Chromium because it is such a dangerous chemical for humans to be exposed to.

#### Levels of Chromate that Produce Lung Cancer

The EPA has determined that an acceptable cancer risk is one cancer in one million people, and thus the levels of an agent that would produce this incidence of cancer are often determined by the EPA. For Hexavalent Chromium, this level is very small (80 picograms per cubic meter or  $8 \times 10^{-5}$  ug per cubic meter). This quantity is so small that one could not begin to see it with the human eye. The OSHA Occupational standard for an eight hour per-day work week has recently been reduced to five micrograms per cubic meter. The old standard was 100 micrograms per cubic meter, which was lowered because at this level, many workers still developed lung cancer, according to recent epidemiological studies of chromium refinery workers in Baltimore, MD. These recent findings showed a high excess of lung cancer incidence at 40 micrograms-per cubic meter. I will show you in a vial how little 40 micrograms of Sodium Dichromate is and we will also show you the size of a cubic meter of air.

Because such low levels of chromate cause lung cancer, it is very dangerous for humans to become exposed to this agent.

### Health Effects of Hexavalent Chromium

Workers exposed to Hexavalent Chromium in the air typically have respiratory problems including difficulty in breathing, coughing, sneezing, dyspnea, skin rashes, eye irritation, 20-30% decrease in forced respiratory volume, runny nose, the lungs become filled with white blood cells and other inflammatory mediators, and nose bleeds. The effects on the nose can lead to nasal septum perforation, where the wall separating the nasal passages develops a hole, which is commonly referred to as “Chrome Holes.” Chronic tonsillitis, chronic pharyngitis, and atrophy of the larynx or voice box have been reported. Individuals may also become allergic to Hexavalent Chromium and develop asthma symptoms such as wheezing and difficulty in breathing. Contact with the skin can produce what has been termed chrome ulcers in the skin. Stomach pains, cramps and stomach ulcers have been reported. In workers exposed to Sodium Dichromate, the Hexavalent Chromium can enter the body by inhalation, by ingestion and through damaged skin. Respiratory symptoms predominate if it enters by inhalation, but if ingested, severe damage to the all parts of the GI tract can occur.

In the Erin Brockovich case, the most common route of exposure to Hexavalent Chromium was by ingestion and there were a number of young women who lost their colon and small intestine from the corrosive and oxidizing effects of ingested Hexavalent Chromium. In the Brockovich case, there were elevations in cancers of kidney, breast, testes, stomach, pancreas, duodenum, bile duct, and lung. Leukemia and Hodgkin’s and Non-Hodgkin’s Lymphomas were also elevated. Hexavalent Chromium can cause severe

damage to the liver and kidneys, depress the immune system, and can enter every cell of the body and potentially produce widespread injury to every major organ in the body. This is because it looks the same as the nutrients sulphate and phosphate and is actively sucked up into cells by carriers that would normally transport these essential nutrients. It is very dangerous for humans to become exposed to even small amounts of Hexavalent Chromium. The type of damage and cancer will generally depend upon one's genetic susceptibility.

#### Human Exposure to Hexavalent Chromium at Quarant Ali Water Treatment Plant

The surface soil levels of Sodium Dichromate at the Quarant Ali Water treatment plant were very high (e.g. 16,459 mg/Kg which is 1.6% Sodium dichromate by weight). A single air-monitoring test, at human breathing levels, in the absence of winds and other factors that could disperse Sodium Dichromate from the soil found, as expected, very little Sodium Dichromate present. However, as indicated by Sudhir Desai in KBR internal documents, more air monitoring tests with winds present should have been conducted to get a more accurate diagnosis of potential human exposure.

The proper test to detect the presence of Hexavalent Chromium in people exposed is to measure the levels of chromium in the red blood cell. This will distinguish Hexavalent Chromium exposure from Trivalent Chromium, which can be present at high levels in the plasma and urine, but will not enter the red blood cell. The Trivalent Chromium will mask the detection of Hexavalent Chromium exposure if only serum and urine measurements are conducted. It is my understanding that this is the type of inadequate and improper test that was conducted on approximately 250 members of the

Indiana National Guard who were exposed at the Qarmat Ali plant, not the proper test that measures the red blood cell level of chromium.

Even if the proper test was performed more than 90 days after exposure, it would have been too late to have detected exposure since the human red blood cell life is 90 days. The half life of Hexavalent Chromium in the body is 39 hours, which means if only plasma or urine levels were measured, elevated levels of total chromium (Hexavalent Chromium included) would be detected days later only if the exposure was huge. The type of test that was used to test the soldiers would have to be conducted within four days of exposure; otherwise most of the chromium in the urine or serum would be gone.