Corporate Corruption of Science—The Case of Chromium(VI)

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Corporate infiltration of a panel convened to set standards for chromium(VI) in California, buttressed by the engineered production of dubious "scientific" literature advancing industry's goal, succeeded in skewing the panel's decision to protect industry profits rather than public health. This situation demonstrates the insidious and effective influence of industry on the regulatory process. *Key words*: industry influence; scientific integrity; regulation; standards.

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Examination of the circumstances surrounding the regulation of chromium(VI) in the state of California exposes how an effort to achieve objective scientific review can be influenced by corporate-manipulated science, much of it "laundered" to appear unbiased and truthful. We use the example of California's attempt to regulate chromium(VI) to demonstrate the insidious and effective influence of industry on the regulatory process.

On November 9, 2001, California's Office of Environmental Health Hazard Assessment (OEHHA) withdrew its total chromium Public Health Goal (PHG) of 2.5 ppb.[1] The PHG of 2.5 ppb, established in 1999, had represented a significant decrease from the state-legislated 50 ppb level and had been based on data showing that orally ingested chromium(VI) presented a carcinogenic hazard. The OEHHA withdrew the more protective standard just two months after the publication of a report written by a "blue-ribbon panel" convened at request of the state with the aid of the University of California.[2] The panel had been established in part to review findings from the study by Borneff et al.[3] showing risk of chromium(VI) ingestion. In the end, the panel's report disparaged the Borneff data and asserted that chromium(VI) is not carcinogenic when ingested.[2]

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However, the findings of the panel's report and the subsequent withdrawal by the OEHHA of its 1999 PHG were not based on valid science but were rather the cumulative result of industrial scientific corruption. The report itself was later discredited as a result of two state senate hearings that investigated corporate manipulation of the panel, brought to light by attorney Gary Praglin and Senator Deborah Ortiz.[4]

Corporations manufacture scientific doubt to forestall actions that are needed to protect public health. Industry engages a host of performers, including law and PR firms, to implement this strategy, but perhaps most troublesome among them are scientists who are willing to bend ethical standards and scientific processes to achieve the doubt needed to forestall public health interventions. Corporate domination of the chromium (VI)-toxicity blue-ribbon panel is emblematic of hidden corporate influence on science. We need to draw lessons from this example to protect the integrity of the scientific process and the health of the public.

Chromium pollution was brought to public notice by the movie *Erin Brockovich*, based on a lawsuit brought by the town of Hinkley, California, against Pacific Gas & Electric (PG&E) (*Anderson v. PG&E*). However, problems with the carcinogenic metal are not limited to those described in the film; they began before and have continued long after the filming and theater run. Corporations that use chromium (IV) extensively have long opposed tightening of chromium (VI) standards, arguing that it is not a cancer-causing agent when ingested orally (the carcinogenic effect of inhaled chromium (VI) is undisputed). Industry takes this position because a tightening of the standard would require additional environmental controls and result in added company expenditures.

PG&E had a particularly high financial risk related to the outcome of the blue-ribbon panel's deliberations. The company had originally used chromium (VI) as a corrosion inhibitor in its cooling towers, then dumped the chemical into unlined wastewater ponds, which eventually leached into the water supply.[5] The company settled the *Brockovich* lawsuit for $333 million. A loosening of chromium standards would protect

against future lawsuits as well as help avoid millions of dollars of potential clean-up costs. With much to gain, PG&E and allied chromium companies had long been trying to influence regulations restricting chromium exposures. We examine how the company exploited the blue-ribbon panel to build on past work and add new strategies to avoid liability, shifting the costs resulting from its environmental pollution from PG&E to those exposed to PG&E's toxic effluent.

CONVENING THE PANEL

In March 2000, the release of *Erin Brockovich* raised public awareness and concern over chromium (VI). In a series of responses, the California legislature passed a law requiring the levels of chromium (VI) to be monitored in drinking water, and the California OEHHA announced it was setting the stage to establish a maximum contaminant level (MCL) to control exposure.[6] To achieve this end, it sought to convene a panel of experts to review the current literature and make recommendations for a chromium (VI) public health goal. By early 2001 a contract was executed with the University of California at Davis to convene the "blue-ribbon panel," hold at least one open hearing, and present a report.[7] Dr. Jerrold Last chaired the panel and recruited six other experts.

Documents obtained on discovery for a new PG&E lawsuit show PG&E viewed the creation of this panel as an opportunity to change the scientific view of the carcinogenicity of chromium (IV) ingestion:

> The good news is that CA-EPA is going to attempt to broaden the base of expertise used to develop the PHG from just a few folks within OEHHA (which is what they did the last time) to a panel of experts. However the key is to get the panel to have some real independent experts, and not just the plaintiff's usual suspects... If the panel of experts is being formed, then we need to find out how to get names in front of the decision makers.[8]

PG&E's lobbyists e-mailed a firm of scientific consultants, Exponent, that had a long-standing relationship with the chromium industry

> We will be lobbying hard for balanced representation . . . it is critical that we get you and/or Deb Proctor or others on the non-alarmist side of things.[9]

"BALANCED REPRESENTATION" OF SCIENCE AND SCIENTISTS?

Within a week this effort paid off. The consultants reported that their Vice President, Dennis Paustenbach (formerly the principal of ChemRisk), had been appointed to the panel. With relief, Brent Finley of Exponent stated,

> So it looks like we got "one of our own" on the panel.[9]

In his e-mail announcing Paustenbach's appointment to the panel, Finley indicated that Dr. Last knew about Paustenbach's research on behalf of PG&E but "does not think this is a conflict."[9] Despite being informed of this conflict of interest, colleagues trusted that Paustenbach would provide unbiased input to the panel. PG&E later stated that

> Dr. Paustenbach's participation on the panel was not at the behest of either PG&E or its counsel.[10,p.9]

At the time Paustenbach was serving on the panel, PG&E was using the firm where Paustenbach was Vice President, Exponent, to work on chromium issues.[11,pp.14–15,12] Paustenbach claims he

> . . . had not worked for PG&E as a consultant for nearly 7 years and PGE had assured him would not be serving as an expert in the foreseeable future.[13]

Another PG&E consultant, Dr. Mark Schrenker, was also appointed to this panel. Paustenbach claims Dr. Schenker had not agreed to serve as an expert witness for PG&E in a lawsuit brought by residents of a second city in California against PG&E (*Aguayo v. Betz, PG&E, et al.*).[13] PG&E listed Schenker as a witness in *Aguayo v. Betz, PG&E, et al.* in 1999.[14] California court rules require that a potential witness agree to testify prior to being listed in a case.

In a later court motion, PG&E argued that

> The suggestion that the Committee's evaluation of the scientific literature on chromium (VI) resulted from undue influence from PG&E is unfounded and absurd. The members of the Committee were selected by University of California; PG&E had no involvement in this process whatsoever.[10,p.14]

The chromium corporations have a long history of creating industry-friendly research to impact rule making. In the early 1980s, Marianne Kaschak served as project coordinator at the Industrial Health Foundation, which served as the co-coordinating agent for the chromium industry through its Chrome Coalition. In early 1984, the Chrome Coalition had handpicked a small group of advisory scientists, the IHF Chromium Working Group.[15] One of IHF's contracted vendors, Inveresk Laboratory, submitted a report to IHF. The findings of the Inveresk report were apparently not to the group's liking: Inveresk found "unexpected mortality" among one group of rats and "100% mortality" of rats in another test.[16,17] Kaschak asked the Chromium Working Group scientists to comment on the methods, so the allied scientists could express their joint displeasure.[18–22] This precipitated a meeting of the scientists, an

agreement on the parameters of the criticism, and a plan to rerun the research at the laboratory of another working group member.[18,19] In response, the ousted laboratory argued that it had run the tests as originally advised.[23] Kaschak refused to pay the Inveresk group for its work; she was clear that the policy was to hold part of the agreed-upon payment not until completion of the study, but until "acceptance" of the final report.[16] In fact, after the Inveresk controversy, IHF's standard research contract was changed to withhold even more payment, 50% of the total, until the final report was accepted.[24] In an effort to get paid, Inveresk vainly argued, "we cannot be held responsible for unexpected deaths which truncate an experiment."[23] Kaschak's response indicates that the IHF had created a climate of compliance; payment would be contingent on the direction of the "results" and not the quality of the work.

One of the Chromium Working Group scientists, Dr. Silvio De Flora, was involved in the joint criticism and planned replication of the Inveresk research, and was conducting industry-funded studies supporting the theory that chromium(VI) was safe to ingest.[15,19,25] De Flora also served as a witness for PG&E from 1995 to the present time.[14,26] In 2000, De Flora co-authored a review of chromium(VI) toxicity that the blue-ribbon panel cited four times to buttress its conclusion that chromium(VI) ingestion was safe.[2,27] (See below.)

According to PG&E, Dennis Paustenbach is one of the "world's leading scientists on chrome (VI) toxicology."[10] Much of this expertise was obtained in the course of his consulting, which was predicated on developing results that would protect his corporate sponsors' net income. Maxxus Energy, along with several other firms with chromium pollution liability, paid approximately $7.1 million to Paustenbach's employer to "deal with the chromium problem" in New Jersey,[28] PG&E paid $1.5 million for consulting on the Hinkley *(Brockovich)* case, and Merck Inc. paid over $75,000 to Exponent for work on chromium.[29]

In mid-1990s, facing a possible OSHA decision to set a permissible exposure limit (PEL) for chromium(VI), the Chrome Coalition solicited proposals from several consulting firms to critique OSHA's risk-assessment techniques and standard-setting process. Paustenbach's ChemRisk responded with suggestions designed to cast doubt on existing science and thus delay action:

> As an example of an approach that works Dennis cited the recent agreement between industry and unions to lower the PEL for 1,3- butadiene from 1000 to 1 ppm. Although OSHA originally wanted to lower it even more, they have announced that they are strongly considering this agreement. The establishment of a PEL for benzene of 0.5 ppm rather than 0.1 ppm was also cited as a recent instance of a large scale effort that produced a result industry could live with that was not as low as OSHA had originally wanted to go.
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> Dennis Paustenbach discussed several other strategies such as pitting the ACGIH TLV Committee against the OSHA-PEL Committee by the submission of various information reflecting risk analysis. He also felt very strongly about conducting the analysis and submission of papers that have been peer reviewed into the docket as soon as possible since OSHA would be required to address them in the standard setting process. And finally, he illustrated the point that the Johns Hopkins data must be thoroughly analyzed beyond what EPA/OSHA had contracted for, so that the issue of hexavalent chromium exposure is evaluated properly now and that further misconceptions like Mancuso are dismissed.[30,31]
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> Dr. Paustenbach also
>
> stated that he has had informal discussions with the principal researchers at Johns Hopkins involved with the chromium epidemiology study. They verified that EPA will not offer additional financial support to complete the study. However, Genevieve Matanowski of Johns Hopkins discussed the possibility of pro bono ***confidential*** involvement of ChemRisk to see the study to completion. Dr. Paustenbach suggested that, if this were to come about, the Chrome Coalition might wish to approach the regulators with a program designed to fill a "data gap," thus entering into a data gap agreement, to forestall the rulemaking. [Emphasis added]

Importantly, he stressed the need to conduct the analysis and submission of peer-reviewed papers as soon as possible, so OSHA and others would be forced to consider them. The industry representatives were impressed, and one group immediately pledged half of the needed 120 thousand dollars

Paustenbach's 1996 proposal to the Chrome Coalition is disturbing for its evidence that some scientists are willing to design an entire scientific campaign to delay public health interventions that will save human lives. In fact, by 1996 Paustenbach was already employing his recommended methods on behalf of chromium, and his firm had been working for PG&E directly through 1995. Spurred by the judge's conclusion that a 1987 study by Dr. Zhang Jiandong was an important piece of evidence in the ongoing Hinkley trial, PG&E contracted with Paustenbach's firm, ChemRisk, to counter the offending research, ultimately creating a manuscript that for years would successfully cast doubt on the original 1987 Zhang study,[32] which reported elevated cancer rates in residents of Jinzhou, China, who were exposed to the excess disposal of 300,000 tons of chromium(VI) waste water. The findings of this study had provided key factual data supporting the reduction of chromium(VI) standards and encouraged many states to lower their acceptable chromium(VI) levels. To successfully support PG&E's view, ChemRisk had to overcome opposing conclusions in the existing medical literature, including the key paper by Zhang.

To invalidate the Zhang study and support PG&E's position, ChemRisk hired Dr. Zhang in 1997 and proceeded to rewrite his paper. This ChemRisk paper, published in the *Journal of Occupational and Environmental Medicine* (JOEM), claimed that Dr. Zhang had re-evaluated his findings and reversed his conclusions.[33] However, no Chinese translation of the revised version was made, and therefore it is hard to see how the non–English-speaking Dr. Zhang could have approved its contents.[34,35] ChemRisk and Dr. Zhang communicated through a ChemRisk translator (Mr. Ye), who has testified that Dr. Zhang disagreed with the ChemRisk conclusions.[35] In addition, contrary to JOEM's standard procedure, PG&E's funding of the article was not disclosed, and ChemRisk's ghostwriters were not acknowledged in the article. Furthermore, most communication concerning the paper's revision was done via Mr. Ye's (a ChemRisk employee's) private home, obfuscating the corporate participation in this "reanalysis."[34] In 2005, the *Wall Street Journal* reported that Zhang's son was outraged at the idea that his father would willingly have invalidated his earlier award-winning work.[34]

Paustenbach and the firms for which he worked, ChemRisk and later Exponent, thus engineered scientific doubt to meet the financial needs of their industrial clients. Instead taking the high road scientific transparency, ChemRisk engaged in various strategems to hide its and the Chrome Coalition's association with the products (scientific papers) of their alliance. ChemRisk's creation of an anti-Zhang manuscript was contracted through PG&E's lawyers, a strategy often used to hide work behind a shield of attorney–client privilege.[36,37] Later Chrome Coalition documents describe the reason for hiding potentially incriminating documents behind attorney–client privilege,

> I agree that Exponent should draft the responses to questions 1–14, but recommend that their work be contracted for and supervised by Collier Shannon. If we retain Exponent and supervise that project, we can maintain attorney client privilege over all analysis they generate. Although unlikely, it is possible that OSHA or private litigants could request such information from the Chrome Coalition or its member companies in future personal injury lawsuits. Perhaps more important, this info request is designed to build the record for future rulemaking. Therefore, the response should include legal arguments as well as data and analysis. . . .[36,38]

The corporate law firm's claim that it was relying on Paustenbach for legal advice may have been an attempt to justify the use of "privilege." It is certainly an unusual role for a scientist and begs the question of practicing law without a license.

This ploy echoes the tobacco industry's strategy of using lawyer-controlled science to spread doubt about the tobacco–cancer-causation nexus. Courts later found that these efforts at circumventing the legal discovery process constituted a fraud on the legal system.[39] Paustenbach's suggestion that his assistance to Johns Hopkins's researchers be "confidential and probono" is easily understood as evidence of a concerted and conscious effort to conceal corporate influencing of science.[31]

Brent Kerger, one of Paustenbach's senior scientists at ChemRisk, would later testify that

> I would have loved to have been an author, a co-author, and I'm sure Dennis Paustenbach would have loved to be a co-author on this paper, the Zhang and Li [1997] paper. But Dr. Zhang—and I agree with him completely—was of the opinion that the original research and study was done 20 years ago, that was the bulk of work that was done on that particular paper or, you know, what was his publication on it, and our collaboration was relatively minor in that big picture.[40]

This later claim that ChemRisk's principals wanted to get credit for their contribution to the second Zhang paper rings false in light of Paustenbach's contemporaneous efforts to secure "confidential" ChemRisk involvement in data analysis.[31] Additionally, according to the *Wall Street Journal*, "Mr. Ye didn't recall Dr. Zhang ever telling him that."[34] In 2002, Jay Beaumont, a scientist at the OEHHA, reviewed the two Zhang studies. This review initially raised a few questions in usage of terms, spurring a deeper investigation.[41] As a result, the California EPA drafted a summary of problems with the Zhang paper (Table 1).

IMPACT ON THE REGULATORY PROCESS

The blue-ribbon panel paid particular attention to the only large epidemiologic study of a population exposed to disposed chromium (VI), Zhang's two articles.[33,43] Of the three pages in the panel's report dedicated to a review of human studies related to chromium, over a page is given to discussion of the Zhang studies. The panel relied on the second, ostensibly follow-up, study, written by ChemRisk but attributed to Zhang and Li, which contradicted the first Zhang paper (the one he actually wrote) to conclude that ingested chromium (VI) was less dangerous then previously believed.

PG&E, via Paustenbach, has managed to seed the literature with a high-profile study engineered solely to cast doubt on the toxicity of chromium (VI). This study is but the tip of the iceberg of deceit. In 1996 Paustenbach via ChemRisk advised the Chrome Coalition of the need to create peer-reviewed pro-industry research, including a full review of all epidemiologic research on chromium.[30,31] Work was swift; by midyear one of their staff reported to the PG&E lawyers that the firm had no fewer than eight articles under review.[44] Later in 2001, the blue-ribbon panel reviewed all epidemiologic

TABLE 1 Scientific Issues Regarding Zhang and Li, 1997[33]

Misrepresentation of data and study design

- Represented the observed number of cancer deaths in the villages as actual counts rather than estimates.
- Didn't disclose that village population estimates were based on 1982 census.
- Ignored useful data that were available, e.g., stomach cancer rates for Liaoning province and Tanghezi village.
- Misrepresented the epidemiologic design as a higher-quality cohort study by describing "follow-up" of the populations and calling it a "retrospective mortality study."
- Evaluated the pattern of chromium contamination detected in wells in 1965 knowing that by the end of the year the picture of contamination in the wells had dramatically changed.

Professional standards

- Non-disclosure of who wrote the manuscript.
- Non-disclosure of study funding.
- Simultaneous submission to two journals, including signing form(s) stating that the manuscript has not been submitted elsewhere.
- Falsely stated in the published paper that site-specific cancer rates weren't available for the province (the authors had the rates in hand).
- May not have disclosed finding of excess stomach or lung cancer risk, which would have been important for protection of public health.

Epidemiologic design

- We don't know what standard population was used for age-standardizing the village rates. The 1997 paper doesn't say. The standard population that was used for age-standardizing the village rates needs to have been the same as that for the province to fairly compare with the province.
- The epidemiologic study design should be classified as ecologic, because the data (village-wide cancer rates and drinking water concentrations) described geographic areas rather than individual subjects. Ecologic studies are generally thought to be inferior to cohort and case–control studies because they can be insensitive to small increases in risk.
- The 13-year observation period after first exposure was relatively short for a study of human cancer, because many cancers could occur after the end of the observation period.[42]

research on chromium. The panel's report moves seamlessly from a discussion of the Zhang studies to language wholly lifted from Paustenbach's industry-funded review of chromium epidemiology. The chair, again showing awareness and disregard of ethical conflicts, acknowledged the need to make it look as if they had not copied Paustenbach's work,

> we don't want to look like we are rubber stamping Dennis' [Paustenbach's] conclusions (they come with baggage this apparent conflict of interest).[45]

With an epidemiologic review almost completely based on the Paustenbach-engineered Zhang reversal and Paustenbach's review of other studies, the blue-ribbon panel unsurprisingly concluded,

> Taken together the epidemiological data on chromium (VI) exposure from environmental sources (as opposed to generally much higher occupations exposures) provide no support for a causal association for exposure of chromium (VI) and site-specific or overall cancer mortality for the general public.[2,p.19]

Industry attempts to "launder" its influence make it difficult to gauge how much of the evidence presented to the panel was touched by industry money, but an example from chapter three of the panel's report raises additional concerns. In a duplication of the strategy used with Zhang's research, the authors rely on a review of studies by De Flora to criticize previous work demonstrating that chromium (VI) is genotoxic when ingested.[27] The report quotes De Flora statements that "oral chromium is not genotoxic at doses which greatly exceed the drinking water standards."[2,p.14] De Flora identified only the Associazione Italiana per la Ricerca sul Cancroas as a funder of his paper.[27] However, he concurrently served as an expert witness for PG&E.

By the time the blue-ribbon panel conducted its open hearing in July 2001, Paustenbach states that the following had occurred

> I contacted the Panel chairman (Dr. Last) and told him that I was considering resigning because I had a sense that plaintiff counsel (or others) was going to claim that I had a conflict of interest and that they would attempt to discredit the hard work of the panel. Dr. Last insisted that my resignation was not necessary and that, as scientists, we should not succumb to these pressures. I asked him to bring the matter before the panel. To his surprise, the panel said that in order to minimize controversy they would accept my resignation. Ultimately, I should not have succumbed to the possible pressures brought to bear by special interests.[13]

PG&E's plan extended well beyond getting "one of our own" on the panel. In April 2001 PG&E's lobbyists, Kahn/Pownell, outlined a three-pronged strategy:

> Reassemble and fortify Alliance for Responsible Water Policy; Establish expert contacts and database on chrome (VI) science; Choreograph the required interactions among the affected community, legislative and regulatory officials, and outside expert advocates in a manner that supports strategic objectives.[46]

By the July hearing, some of the objectives had already been met, such as getting scientists on the panel and creating a review of available evidence with support from outside scientists. Most of these strategies involved the creation of a group of advocates who would appear independent, but were in fact creatures of industry. The occasion of the blue-ribbon panel's public hearing provided PG&E a perfect opportunity to implement these plans.

On July 25, 2001, Exponent's Ms. Deborah Proctor presented to the blue-ribbon panel and supplied the body with an unpublished manuscript, "The Weight of the Evidence Review," that she and Dr. Paustenbauch had written.[47,48] She gave testimony as a representative of the Alliance for Responsible Water Policy, without acknowledging either that the Alliance was funded by PG&E or that she had consulted for PG&E in the past.[48] At the time she was acting as an expert panel presenter, Ms. Proctor was also being paid by PG&E to monitor the progress of the panel.[11,49] On May 26, 2001, in a monitoring report, Ms. Proctor wrote to PG&Es lawyers,

> with your approval I have approached Phil Cole about Lockheed or the Alliance for Responsible Drinking Standards fund him to finish and present to the panel. Phil is most comfortable having PG&E fund completion of the manuscript, rather than an outside party, and is very busy for the next few months. He is willing to present his findings to the panel. Thus at this point I am trying to work through Dennis to get the panel to invite Phil to present to them and through Lockheed and Eric Newman to get funding if the panel cannot fund him.[12]

Phil Cole, a current PG&E expert witness, testified at the blue-ribbon panel's hearing and shortly thereafter received a $6,467 check from the Alliance for Responsible Water Policy as payment for this work.[11,14] One other current PG&E expert witness, Dr. Sverre Langard, was "sponsored" by the Alliance and paid $15,000 to present a pro-industry perspective at the blue-ribbon panel's hearing.[11,26] Dr. Langard did not disclose his industry ties to the panelists.[48] Dr. Langard allowed industry lawyers to craft his cover letter to the panel chair and took direction on what to include and what to exclude from his testimony.[11,p.23] His lawyer-fashioned words summarized the industy's position,

> In sum, the epidemiological literature does not support an association between chrome (VI) exposure by ingestion (or inhalation for that matter) and gastrointestinal cancer.[50]

BLUE-RIBBON PANEL FINDINGS

The executive summary of the blue-ribbon panel's report states "We find no basis in either the epidemiological or animal published literature for concluding that orally ingested chromium (VI) is a carcinogen.[2,p.3] The similarity in word and intent to industry-funded documents was no accident. Industry influence, much of which was deliberately hidden, drove the blue-ribbon panel's actions and conclusions.

PUTTING THE RESULTS TO USE

The publication of the blue-ribbon panel's report spurred several responses. PG&E lawyers, faced with a second town initiating a lawsuit against them, were quick to file a motion introducing this evidence in an effort at dismissal.[10] The same lawyers were also quick to write an article—later published in *Natural Resource and Environment*—claiming the release of this report was the "death blow" for all chromium litigation in California.[51] Meanwhile, the state of California reviewed the information and within two months withdrew its 1999 PHG for chromium in drinking water of 2.5 ppb.[6] Upon release of the findings, Paustenbach e-mailed his colleague, Brent Kreger:

> Buy a good bottle of wine, pull up a chair… and then read this. Then, say to yourself "Yup, I finally did something good for society."[52]

POST-FINDINGS

Whistleblowers Gary Praglin and Senator Ortiz initiated two state senate hearings that spurred OEHHA's eventual rejection of the blue-ribbon panel's report and, consequently, a delay in California's establishment of a chromium (VI) public health goal.[48] PG&E, currently the defendant in a billion-dollar lawsuit in which the plaintiffs are represented by Mr. Praglin, denied involvement with the panel, and prior to the senate hearings filed rebuttals to every accusation. Dr. Paustenbach believes that in the senate hearings and media coverage of the blue-ribbon panel he was "made into a bogeyman," and often quoted out of context.[4] He now wishes he had not resigned from the panel so quickly and says that it was "a very pure panel."[4]

At our suggestion the Editor submitted a version of this paper to Dennis Paustenbach for his comment to assure accuracy. We have made appropriate changes and/or efforts to incorporate his views of the events that occurred. The final manuscript is ours alone.

Paustenbach began his comments with the following admonition, "If you [Joe Ladou] choose to publish it, you, the authors, and your publisher will expose themselves to the ethical, professional and legal repercussions of making claims that are known to be incorrect."[13] We have an ethical and professional obligation to further discussion of the issue of corporate corruption of science. On the other hand, Paustenbach's threatened "legal repercussions" do not represent an appropriate response to the exchange of views on these critical issues.

CONCLUSIONS AND RECOMMENDATIONS

At several junctures, Cal/EPA, the University of California Davis, Jerold Last, and other member scientists of the blue-ribbon panel failed to establish conflict-of-interest standards for panel members. As a result of corporate manipulation of science, effective regulation of chromium (VI) in California and New Jersey (and elsewhere) has already been delayed for about a decade. Corporations faced with multi-million-dollar litigation or regulatory actions do not naturally deserve our trust, neither do the paid professionals who help them achieve their goals. As Klosterman has recently written,

> There is a lot of confusion about the word objective. Somehow, it has become common to assume that an objective person has no opinion about anything. That's not what the word means. Being objective means that you understand your own personal biases, and you compensate by intellectually separating yourself from your preexisting feelings. It's something you *do*; it's not something you inherently *are*.[53]

Tailoring findings to meet the financial needs of a sponsor is the definition of non-objective, slanted, science.

We have several suggestions:

1. Panels should be balanced with consultants whose prior research has represented a true range of findings on the topic at hand. If scientists who have worked for industry are included on a panel, they should be balanced by others who have worked for public interest or environment groups. We do not seek to exclude consultants who have industry ties; we seek to have those ties disclosed and data verified. We think scientists should follow Ronald Regan's advice, "Trust but verify."

2. Journals should demand disclosure of all communications between funders and researchers when papers are submitted.

3. Authors should submit all raw data to journals and after acceptance this information should become part of the public domain.

4. Now that problems with the second Zhang manuscript have come to light, it is incumbent on the *Journal of Occupational and Environmental Medicine* to conduct a thorough investigation. We feel enough evidence has been presented to retract the paper.

5. Authorship and editorial assistance should be accurately listed or acknowledged. Listed authors who knowingly use ghostwriters' work are guilty of plagiarism, and should be subject to their institutions' academic codes. Academic institutions should not allow faculty to take credit for papers written by others. Faculty should be held to (at least) the same standards as students.

Note added in proof: Since the submission of this document, Drs. Brent Kerger, Dennis Paustenbach, and William Butler have all replied to the *Wall Street Journal*'s December 2005 exposé regarding the second Zhang paper. According to Kerger, the findings were justified because ". . . we found that Dr. Zhang had written in his earlier Chinese manuscripts around 1986 that increased cancer rates weren't associated with increasing chromium drinking-water levels."[54] Oddly though, the 1997 paper contains no references to any Zhang papers from this time period. Kerger further contends that "decisions on co-authorship and the lack of acknowledgement of funding from Americans seemed appropriate" because of "political pressures" in China.[54] It is ironic that the chromium industry was able to convert these Chinese "political pressures" into political victories in the United States.

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