

**Statement of Dr. Raymond S. Hartman
Presented to
the Massachusetts Joint Committee on Public Health**

**Critique of the Massachusetts Department of Environmental Planning (DEP)
“Wind Turbine Health Impact Study,
Report of Independent Expert Panel,” January 2012.**

July 9, 2013

In favor of Bills H.2048, H.2089 and S.1041

**The passage of these bills is necessary to provide scientific research
into the health impacts of wind turbines in Massachusetts
which was not provided by the *Health Impact Study*.**

**The reasons that the January 2012 *Health Impact Study* cannot be relied upon
are found in the following statement.**

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Executive Summary

I have been asked by a group of residents of the Commonwealth of Massachusetts to review the report submitted in January, 2012 to the Massachusetts Department of Environmental Planning (DEP) by an “Independent Expert Panel” to assess the health impacts of Industrial Wind Turbines (IWTs). Having done so, I conclude that the purported “independent expert panel” was not independent. It was no more “expert” than scientists whose research was dismissed or marginalized by the Panel. The Panel and its staff conducted no independent primary scientific research, even though it recognizes how such research should be conducted and it had ample opportunity to sample nearby, highly relevant, Industrial Wind Turbine (IWT) installations in the Commonwealth and in New England. It dismisses or marginalizes a significant body of research conducted by scientists with credentials as good as, or better than, the credentials of the Panel members. Instead, the Panel relies upon a very limited number of research articles and after doing so comes to very strong conclusions. That in itself is questionable scientific practice. More importantly, the Panel misstates the full context of the research upon which it relies.

I conclude, therefore, that the Wind Turbine Health Impact Study conducted by the Independent Expert Panel and presented to the Massachusetts DEP in January 2012 is biased, inaccurate and a fairly transparent mischaracterization of the existing scientific research. It cannot be relied upon to support the contention that IWTs have no impact upon the health and well-being of neighboring residents. The report has little scientific merit.

My testimony proceeds as follows. In Section I, I introduce my qualifications to put forward this analysis. In Section II, I summarize my conclusions. In Section III, I present in greater detail, the research finding of the research papers upon which the Panel relies. I demonstrate that these research papers find adverse health impacts and nuanced

conclusions about how IWTs impact human health and well-being. This discussion demonstrates that the Panel's reliance upon them as proof that IWTs have no adverse health impacts is a gross mischaracterization.

I. QUALIFICATIONS

1. My name is Raymond S. Hartman. I am Director and President of Greylock McKinnon Associates (GMA), a consulting and litigation support firm located in Cambridge, Massachusetts.

2. I am a mathematical economist specializing in microeconomics, econometric and statistical modeling and the study of industrial organization. I have taught economics, conducted economic and econometric research and provided consulting in my areas of specialization for forty years. I taught economics as an Assistant Professor and Associate Professor within the Department of Economics at Boston University over the period 1977-1988. I taught economics as a Visiting Associate Professor and member of the Visiting Faculty at the School of Law, Boalt Hall, University of California at Berkeley over the period 1988-1993. I was a member of the research faculty at MIT over the period 1977-1982, during which time I conducted research in energy markets for the United States Department of Energy. During the same time, I declined the offer of a Visiting Assistant Professorship within the Department of Applied Economics at MIT. Over the entire period since 1971, I have consulted to federal and state governmental bodies, private corporations, law firms, consulting companies, research organizations and international lending organizations. I have been a research referee for a variety of academic journals. I am the author of more than 100 refereed journal articles, book chapters and research/consulting reports.

3. Over the last 35 years, I have submitted oral and written testimony before United States federal and state courts of law and regulatory commissions. I have submitted testimony to international arbitration panels, international governments and the World Bank. My testimony as an expert witness has addressed anticompetitive behavior, fraudulent pricing schemes, merger efficiencies, breach of contract, employment discrimination, patent infringement, class certification, adverse health impacts of particular technologies and products, and the estimation of damages in a variety of markets and industries including, but not limited to, the pharmaceutical industry, the health care services industry, the electric power industry, the banking industry, the copper industry, the defense industry, the cable TV industry, the tobacco industry, the electrical and mechanical carbon products industry, the medical devices industry, the automobile industry, and the construction industry. My testimony has been upheld by federal appellate courts.

4. My two primary areas of specialty are the economics of energy markets and the economics of the markets for health-care services, health-care devices and pharmaceuticals.

5. Over the last thirty-five years, I have submitted testimony, conducted research and/or consulted on a variety of matters of litigation or policy evaluation addressing energy markets and the environmental impacts of alternative energy proposals. I have focused on the markets for electric power and natural gas specifically. My consulting and/or litigation assignments have all included quantitative modeling. I have designed and implemented models for load forecasting, evaluation of conservation and load management programs, econometric cost analysis, analysis of revenue requirements and rate-making, analysis of value of service reliability, the analysis of mergers and acquisitions, analysis of industry restructuring, analysis of manipulation of spot and future prices in energy markets, and analysis of contract damages arising from DOE's Standard Contract regarding storage of spent nuclear fuel waste. In these assignments, I consulted or testified for such clients as Arizona Public Service, the Pacific Gas and Electric Company, the Southern California Edison Company, the Southern California Gas Company, the San Diego Gas and Electric Company, Portland General Electric Company, Bonneville Power Administration, General Public Utilities, Northeast Utilities, Niagara Mohawk Power Corporation, the Delmarva Power Corporation, Florida Power Corporation, Sthe Energies, the California Energy Commission and Public Utilities Commission, the Missouri Public Service Commission, the Rhode Island Division of Public Utilities, the Attorney General of the State of Massachusetts, the Electric Power Research Institute, the Gas Research Institute, the U.S. Department of Energy, the U.S. Department of Justice, the World Bank, and the governments of Indonesia and Thailand.

6. The work that I performed for the Attorney General of the State of Massachusetts and the Rhode Island Division of Public Utilities was undertaken and submitted in 1995-1996. It addressed the economic impacts of restructuring electric markets in New England. Much of that restructuring provides the basis through which alternative energy producers, such as large-scale industrial wind turbine installations and solar photovoltaic installations, are allowed to integrate into the grid.

7. One of my earliest consultations in energy markets was for the United States Department of Energy. Over 1977-1982, as a member of the MIT research faculty, I studied the market feasibility of alternative energy sources, most particularly solar photovoltaic installations. Most recently, over the last five to ten years, I have testified numerous times before the United States Court of Federal Claims on behalf of the DOJ and DOE relating to damages regarding storage of nuclear waste.

8. Over the last twenty years, I have analyzed and/or submitted testimony in approximately 100 matters of litigation in a variety of health-care, pharmaceutical and medical device industries. The cases most frequently involved antitrust allegations of market foreclosure and economic injury. My testimony in these matters addressed market definition, product competition, antitrust violations, class certification, unlawful promotion (under RICO) and/or consumer protection laws, and/or damage estimation. My CV provides a more complete presentation of my testimony.

9. Indeed, I regularly have testified as an expert witness on behalf of the Massachusetts Attorney General's office in a variety of matters, including the 1995-1998 tobacco litigation (the result of which the Commonwealth received billions of dollars in settlement from "Big Tobacco"); litigation against large drug companies for defrauding the Massachusetts Medicaid program (2008-2011); the restructuring of the electric power industry (1990s), mentioned above; and a variety of public utility rate cases (2000s).

10. I received a bachelor's degree in economics (*magna cum laude*) from Princeton University in 1969. I received a master's degree in economics from MIT in 1971 and a Ph.D. in economics from MIT in 1977. My Curriculum Vita is attached to provide specific and recent biographical and professional information (see Attachment A.1). The recent cases in which I have submitted testimony at deposition and trial are provided in Attachment A.2. I have waived any compensation in this matter.

11. In rendering my opinions, I have relied upon the materials reasonably relied on by experts in my field in forming opinions and drawing inferences on subjects such as these.

II. MY ASSIGNMENT AND SUMMARY OF MY CONCLUSIONS

A. Assignment

12. I have been asked by a group of residents of the Commonwealth of Massachusetts to review and critique the "Wind Turbine Health Impact Study" (*hereafter the Health Impact Study*), a report put forward in January 2012 by the panel convened by Governor Deval Patrick and Commissioner Kimmel of the Massachusetts DEP.¹ The stated goal of the research of this *Study* was to identify whether, and quantify the extent to which, Industrial Wind Turbine Installations (IWTs) have adverse health impacts upon neighboring residents.

¹ I note that I am neither for nor against the use of IWTs in all situations. I feel that each siting needs to be evaluated both from a health perspective and from an economic perspective before IWTs should be installed. It is clear from the research that there are health issues in siting IWTs in residential and rural areas and that many of these sites are not economically efficient for IWT sites.

13. I am quite familiar with this study. I reviewed and critiqued it during January-February of 2012, at the request of my neighbors in my home town of Shelburne Falls, Massachusetts. I presented my report to the residents of Shelburne Falls. I also submitted written testimony before the DEP hearing concerning the results of the report.

14. I have reviewed and responded to reports like this in excess of 100 times over my career, as an expert witness and as a peer-reviewing academic research referee.

B. Conclusions

15. The Health Impact Report fails to rise to the level of reliable scientific research. In matters of litigation, research or testimony that does not reflect, or indeed violates, standard scientific practices is excluded from the record as Junk Science. As noted above, I have submitted many pieces of testimony over the last 35 years. My testimony has never been excluded as Junk Science. I find that the Health Impact Study is Junk Science. As Table 1 summarizes, there are major flaws with the Health Impact Study. I further discuss these below in this section and elaborate on the final flaw in Section III.

TABLE 1
MAJOR FLAWS OF THE HEALTH IMPACT STUDY

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|--|
| The Panel who authored the Study was not independent. |
| The Panel who authored the Study is no more expert than the many scientists whose research the Panel peremptorily dismissed. |
| The research design of the Panel is fatally flawed. |
| The Panel failed to implement the appropriate statistical methods to test for the occurrence of IWT-induced adverse health effects. |
| The Panel failed to use readily available and most relevant data for experimental sites in New England. |
| The Panel cherry picked 5 research studies and ignored countless others. |
| The Panel failed to fully report the findings of the limited number of articles upon which it did rely. A more complete reading of these articles reveals scientific findings of adverse health effects. |

16. The Health Impact Study would be excluded for the following reasons.

- a) The “Independent Expert Panel” was not independent.

While the group of academics empanelled to conduct the research was designated as “Independent,” they were not. In complex litigation, courts at times appoint an “Independent Expert” to the Court, to assist the Judge and/or jury to understand the complex technical issues involved. Such Independent Experts are scrupulously vetted, so that they are acceptable to both parties of the dispute – the Defendants and the Plaintiffs (and the attorneys). The Independent Expert must not “have a dog in the fight;” he/she must not have prior preferences for the positions or arguments of one side. If the Independent Expert has any financial or ideological preference for the arguments of one group of adverse litigations, that Expert will simply not be Independent, either consciously or sub-consciously. If an Independent Expert is found to have such prejudices, he or she will be impeached – excluded from serving as a consulting expert.

Several “experts” on the Expert Panel have pro-wind-industry connections. For one important example, I understand that Dr. James Manwell’s Wind Energy Center is heavily involved with the industry and is heavily funded by the Commonwealth. I believe that it is therefore impossible for him to offer a neutral opinion on the health effects of industrial wind turbine installations. Likewise, the Panel was appointed by representatives of the Commonwealth of Massachusetts, which has an obvious infatuation with wind energy. Such a panel cannot be relied upon for impartial scientific judgment. It would certainly be challenged in a legal setting.

I find that many of the Panel members are advocates of Wind Energy. As a result, I find that their report is an exercise in advocacy. It is not science.

- b) The “Independent Expert Panel” is no more expert than the many scientists whose research the Panel peremptorily dismisses.

The Health Impact Report cites, but *improperly* dismisses or marginalizes, research that contradicts the Report’s findings. This research has been conducted by qualified scientists no less expert than members of the Panel. This dismissal or marginalization violates standard scientific practices. It is unacceptable. For one example, the Health Impact Report dismisses the research and work conducted by Dr. Nina Pierpont,² a physician and PhD biologist, whose credentials are as good or better than those of almost all the members of the “Independent Expert Panel.”

² Dr. Nina Pierpont has an undergraduate degree (with honors) from Yale University; an MD from Johns Hopkins University; and a PhD in Population Biology/Behavioral Ecology from Princeton University. Therefore, she is well qualified to diagnose medical problems; she is trained to design and implement statistical models of causality of environmentally induced illness.

Indeed, the design of the research experiment conducted by Dr. Pierpont is exactly the design blessed, but not implemented, by the Independent Expert Panel – a “Before-and-After” study.

- c) The research design of the Independent Expert Panel is fatally flawed.

The research design of the Independent Expert Panel was to *conduct no primary research of its own*. Instead, it reviewed a variety of research efforts; *incorrectly dismissed* most of that research, particularly research that found adverse health effects; and cherry-picked five peer-reviewed articles out of hundreds, which could have been given equal weight. The Panel bases its conclusions importantly upon these 5 articles, even though these studies were conducted in Europe and New Zealand, where the geographical characteristics, the size of the IWTs and wind assets are distinctly different than those found for proposed IWTs in New England.

- d) The Panel recognized the appropriate statistical methods to test for the occurrence of IWT-induced adverse health effects but failed to implement them for the readily-available and the most-relevant experimental sites.

The Panel explicitly recognizes the need for the best statistical method³ – pooling time series and cross-sectional data. Since the Panel should be most interested in the possible impacts of IWTs upon neighboring residents in Massachusetts and similar New England states, it could have implemented such research *where it mattered and where data was readily available* – at the many IWT sites in Massachusetts, New York and New England generally.⁴ Inexplicably, the Panel did not conduct such research. Indeed, it ignored the considerable problems arising at such sites. *As a matter of public-policy research design and implementation, this is unacceptable.*

- e) After conducting no research of its own; and after cherry-picking 5 articles to support its “research;” the Panel further fails to fully report the findings of the articles upon which it relies. *A more complete reading of these articles reveals scientific findings of adverse health effects.* This mischaracterization of the

³ See the Wind Turbine Health Impact Study, pp. 17 & 21, where the Panel discusses the limitations of cross-sectional data analysis to deal with temporal effects. Pooling time-series and cross-sectional data is the statistical modeling method designed to address that concern.

⁴ I understand that, as of January 2012, the ISO-NE seasonal-claimed capability spreadsheet identifies the following IWT sites which could have been used for “Before-and-After” studies: 19 IWT projects in Massachusetts; 9 IWT projects in Maine, including Mars Hill which is outside the ISO-NE area and so is not listed on the ISO's spreadsheet; 3 IWT projects in Rhode Island; 2 IWT projects in New Hampshire; and 2 IWT projects in Vermont.

research upon which it relies is dishonest and renders the conclusions of the Health Impact Study completely without merit.

I develop this final criticism in more detail in Section III.

III. ANALYSIS

17. In this Section I focus specifically on the five articles relied upon by the “Independent Expert Panel.”⁵ I summarize, and quote at some length, the findings of the research developed by these articles. I demonstrate how the Panel failed to report important evidence contained therein, evidence that contradicts the Panel’s interpretation.

18. The five articles reflect research performed by acousticians. Acoustical studies generally gather survey information from the people who are being impacted, either through a time-series or cross-sectional survey. The acousticians hypothesize a dose-response model, relating doses of noise to responses in the surveyed sample of respondents. A time-series survey allows for measurement before and after the installation of the IWT; as such they provide a very precise measure of the change in health status induced by the IWT, which may be the only real change introduced into the survey experiment. Cross-sectional analysis allows for assessing the responses and impacts of survey respondents at a given point in time, where the survey respondents differ from one another in, among other things, personal attributes, attitudes toward IWTs, and most importantly, *proximity to the noise dosage (the IWTs)*. Dose-response

⁵ Specifically the following:

- E. Pedersen and K. Persson Waye, “Perception and annoyance due to wind turbine noise – a dose-response relationship,” *Journal of the Acoustical Society of America*, 116(6), December 2004, pp. 3460–3470.
- E. Pedersen and K. Persson Waye, “Wind turbine noise, annoyance and self-reported health and well-being in different living environments,” *Occupational and Environmental Medicine*, 64, 2007, pp. 480-486.
- E. Pedersen and P. Larsman, “The impact of visual factors on noise annoyance among people living in the vicinity of wind turbines,” *Journal of Environmental Psychology*, 28, 2008, pp. 379-389. Note that this article was only briefly mentioned in the Study.
- E. Pedersen, F. van den Berg, R. Bakker and J. Bouma, “Response to noise from modern wind farms in The Netherlands,” *Journal of the Acoustical Society of America*, 126(2), August 2009, pp. 634–643.
- D. Shepherd, D. McBride, D. Welch, K.N. Dirks and E. Hill, “Evaluating the impact of wind turbine noise on health-related quality of life,” *Noise Health*, 13 (54), September-October, 2011, pp. 333–339.

I note that I excerpt considerable portions of the articles without using quotation marks, since the articles speak well for themselves and there is no need for me to rephrase what has been well-said. In some places, I do use quotes, when the excerpting is exact and the point important.

Since the publication of the January 2012 DEP study, there have been additional publications and studies identifying the adverse health effects of noise exposure. See, for example, M. Nissenbaum, J. Aramini and C. Hanning, “Effects of industrial wind turbine noise on sleep and health,” *Noise Health*, 14(60), September-October 2012, pp. 237-43.

will differ by these attributes and those differences allow for identifying the single impact of the noise and its proximity upon the survey respondents. Both time-series and cross-sectional survey information and analyses are standard quantitative methods. A time-series cross-sectional study is an even better hybrid of the two approaches.

19. After dismissing or marginalizing, incorrectly, much research that is valid and relevant, the Panel states (in bold in the original)⁶ the following conclusions:

- “[T]here is limited evidence suggesting an association between exposure to wind turbines and annoyance.”
- “[T]here is insufficient evidence to determine whether there is an association between noise from wind turbines and annoyance independent from the effects of seeing a wind turbine and vice versa.”
- “[T]here is limited evidence suggesting an association between noise from wind turbines and sleep disruption and that further study would quantify precise sound levels from wind turbines that disrupt sleep.”
- “[T]he weight of the evidence suggests no association between noise from wind turbines and measures of psychological distress or mental health problems.”

20. The five IWT dose-response statistical analyses relied upon by the Panel *do not* support such strong conclusions. I discuss below each of the studies relied upon and show that the Panel has mischaracterized each of the studies and omitted key findings from those studies.

A. E. Pedersen and K. Persson Waye, “Perception and annoyance due to wind turbine noise – a dose–response relationship,” *Journal of the Acoustical Society of America*, 116(6), December 2004, pp. 3460–3470.

21. This paper summarizes a cross-sectional study conducted in Sweden. Residents exposed to varying A-weighted sound pressure levels (SPL) from wind turbines were surveyed in five areas totaling 22 km² comprising 16 wind turbines and 627 households. The survey was conducted in May and June 2000.

22. While the purpose of the study was to measure a dose-response relationship between IWTs and adverse health impacts, that purpose was appropriately masked in the questionnaire, which addressed a variety of perceived advantages and/or disadvantages to living in the rural country side where there also happened to be one or several proximate

⁶ Wind Turbine Health Impact Report, p 28.

IWTs.⁷ When asked about the IWTs, respondents were asked to describe their level of perception and annoyance related to the wind turbine sounds they could hear, using verbal descriptors of sound and perceptual characteristics. Respondents were asked questions about their normal sleep habits: quality of sleep, whether sleep was disturbed by any noise source, and whether they normally slept with the window open. *The turbines were relatively small by today's standards – about 160 feet tall.*⁸

23. “A statistically significant dose–response relationship was found, *showing higher proportion of people reporting perception and annoyance than expected from the present dose–response relationships for transportation noise.*”⁹ As shown in Figure 1 below, this dose-response relationship is expressed as the proportion of nearby residents “highly annoyed” by the dose of noise (measured in dBA, A-weighted decibels¹⁰). The percentage of the population highly annoyed was positive at much lower dBA (32.5) than other forms of transportation noise (aircraft, road traffic and railways; which begin at 42 dBA). The percentage of the population highly annoyed increased much more rapidly than other forms of transportation, reaching 35-40% at 40-42 dBA, that is, before the other forms of noise (even aircraft at airports) even register annoyance. One can conclude that, for some reason, the proportions of respondents annoyed by wind turbine

⁷ The purpose of the survey was not framed as feelings towards IWTs. The survey was designed and implemented as if it were assessing rural living generally. The questionnaire consisted of questions on living conditions, reaction to possible sources of annoyance in the living environment, sensitivity to environmental factors, health and wellbeing. The inclusion of responses to IWTs was embedded in the survey, as if IWTs were just one more aspect of rural living about which the respondents might have some feelings. Perception of and annoyance with wind turbine noise were assessed together with other environmental stressors. “The survey method is well established and has been used in several previous studies exploring annoyance due to community noise” (e.g., E. Ohrstrom, “Longitudinal surveys on effects of changes in road traffic noise-annoyance, activity disturbances, and psycho-social well-being,” *Journal of the Acoustical Society of America*, 145, 2004, pp. 719-729), p. 3467.

⁸ “The towers were between 47 and 50 m in height.” p. 3462.

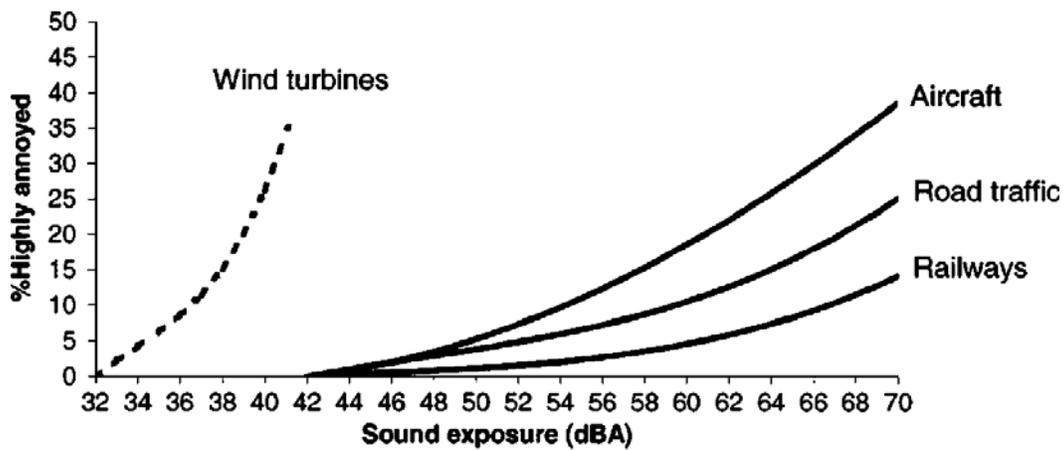
⁹ P. 3460. Dose-response relationships between doses of alternative transportation noise and the response of annoyance were well studied before IWTs became a relevant technology. Three well-known examples include H. Miedema and H. Vos (“Exposure-response relationships for transportation noise,” *Journal of the Acoustical Society of America*, 104, 1998, pp. 3432-3445 and “Demographic and attitudinal factors that modify annoyance from transportation noise,” *Journal of the Acoustical Society of America*, 105, 1999, pp. 3336-3344) and H. Miedema and C. Oudshoorn (“Annoyance from transportation noise: relationships with exposure metrics DNL and DENL and their confidence intervals,” *Environmental Health Perspectives*, 109, 2001, pp. 409-416). The source of Figure 1 below is Figure 3 in Pedersen and Waye (2004). The link between continual annoyance and the adverse health effects has become clearer over the past 15 years.

¹⁰ The authors note that it is possible that A-weighted SPL (sound pressure levels in decibels) do not fully capture the noises that cause annoyance. They note different sound properties (likely low frequency infrasound, measured in Hertz, rather decibels) not fully described by the equivalent A-weighted level, are of importance for perception and annoyance for wind turbine noise. Support for such a hypothesis was given in a previous experimental study where reported perception and annoyance for five recorded wind turbine noises were different, although the equivalent A-weighted SPL were the same (K. Persson Waye and E. Ohrstrom, “Psycho-acoustic characters of relevance for annoyance of wind turbine noise,” *Journal of Sound and Vibration*, 250, 2002, pp. 65-73).

noise are higher than for other community noise sources at the same A-weighted SPL and that the proportion annoyed increases more rapidly. No respondent self-reported being annoyed at sound categories below 32.5 dBA, but at sound category 37.5–40.0 dBA, “20% of the 40 respondents living within this exposure were very annoyed and above 40 dBA, 36% of the 25 respondents.”¹¹

24. “When adding the subjective factor of attitude to visual impact as an independent variable, the influence of the noise exposure decreased, but was still statistically significant.”¹² Almost all respondents (93%) could see one or more wind turbines from their dwelling or garden, so visibility was not the determining factor.

Figure 1
Dose-Response Relationships – % Population Highly Annoyed (y-axis)
Given Level of Noise (dBA)



Sound exposure is for wind turbines calculated A-weighted L_{eq} for a hypothetical time period and for transportation DNL.

25. The authors speculate that the *high prevalence of noise annoyance* could be due to the intrusive characteristics of the aerodynamic sound. The verbal descriptors of sound characteristics related to the aerodynamic sounds of swishing, whistling, pulsating/throbbing, and resounding were reported to be most annoying. “*Most respondents who were annoyed by wind turbine noise stated that they were annoyed often, i.e., every day or almost every day.*” The high occurrence of noise annoyance indicates that the noise intrudes on people’s daily life. The survey was performed during May and June when people could be expected to spend time outdoors, and the results

¹¹ P. 3464.

¹² P. 3465.

therefore reflect the period that is expected to be most sensitive for annoyance due to wind turbine noise. ... Some of the respondents also stated that they were disturbed in their sleep by wind turbine noise, and the proportions seemed to increase with higher SPL.”¹³

26. It should be noted that a rather high proportion, 50%, of respondents self-reported as being rather or very sensitive to noise. Other field studies in Sweden on annoyance due to road traffic noise *in urban areas* have found a lower proportion of noise-sensitive persons. The difference likely reflects some preference of living environment, indicating that *noise sensitive individuals prefer a more rural surrounding* or that people living in areas with low background noise levels might develop a higher sensitivity to noise. The difference might suggest erecting IWTs in noisy urban areas with much higher ambient background noise.

27. One can conclude the following from this paper:

- There was a substantial proportion of the population that was annoyed or highly annoyed by IWT sounds.
- To those that are annoyed, the annoyance occurs every day, every hour the turbines are running. This annoyance is not some simple irritation; it is annoyance that affects mood, well being and health.
- Approximately 25% of the surveyed respondents experienced sleep interruption. As we shall see in the next several papers I review, this effect is common to all surveys. Sleep deprivation is a documented cause of a variety of physical and psychological diseases. Many disease states begin with poor or interrupted sleep. Most modern technologies which create noise and annoyance are noisy during *the day but the noise ceases at night*, giving those living nearby the night time to sleep, relax and recover from the adverse physical and psychological responses to noise. IWTs are unique in that they are noisy day and night. Those adversely affected do not have a quiet night to sleep and recover. Indeed, some studies find that the noise is worse at night, since the ambient noise is reduced and the relative noises of the IWTs are that much greater. The adverse effects of sleep deprivation and annoyance are cumulative.

¹³ P. 3468. Recently, acousticians have hypothesized that low-frequency infrasound is more annoying indoors rather than outdoors. I do not address that issue here.

B. E. Pedersen and K. Persson Waye, “Wind turbine noise, annoyance and self-reported health and well-being in different living environments,” *Occupational and Environmental Medicine*, 64, 2007, pp. 480-486.

28. The paper extends the survey research and policy modeling reported in their (2004) paper discussed above. The objectives were the same. As above, the authors implemented a cross-sectional survey in Sweden. 1,309 questionnaires were sent out; the response rate was 57.6%; that is, there were 754 respondents. The design of the survey and survey instrument was almost identical to that used in the (2004) paper.

29. The survey population (hence the number of respondents) were grouped into 7 groups.¹⁴ The *average* distance for each group to the nearest IWT ranged from a low of 1,984 feet to a high of 3,326 feet. These are fairly long set-backs compared to some siting practices. The average A-weighted noise level (SPL) for all but one group ranged from 31.4 – 35, which is fairly quiet, as noted in Figure 1 above. One group had an average noise level > 35 (38.2 dBA, with a standard deviation of 4.7).

30. The analytic results, conclusions and main messages from the paper are the following.¹⁵

- “The odds of perceiving wind turbine noise increased with increasing SPL [sound pressure levels – measured in dBA], ... [and] [t]he odds of being annoyed by wind turbine noise also increased with increasing SPLs.” ... “Dose-response relationships at noise levels as low as these have not earlier been derived.”
- “[N]oise annoyance was associated with sleep quality and negative emotions.” Of those respondents who were annoyed by wind turbine noise, 36% reported that their sleep was disturbed by a noise source. This is compared with 9% among those not noise-annoyed. Respondents who were annoyed by wind turbine noise felt more tired and tense in the morning. They also felt resigned (29%), violated (23%), strained (19%) and tired (19%) when thinking about wind turbines to a statistically significantly higher degree compared with those who were not annoyed. These feelings were not related to self-reported health status.
- “Perception and annoyance were associated with terrain and urbanization.” “Living in a rural environment, in comparison with a suburban area, increases the risk of perceiving and being annoyed by sound from nearby wind turbines.” “Annoyance was associated with both objective and subjective factors of wind turbine visibility, and *was further associated with lowered sleep quality and*

¹⁴ P. 482, Table 1.

¹⁵ Pp. 480, 484 and 485. I have woven a variety of quotes together from these pages.

negative emotions” which “could lead to hindrance of human restoration.” This, together with reduced restoration possibilities may adversely affect health.”

- “There is a need to take the unique environment into account when planning a new wind farm so that adverse health effects are avoided.”

31. The results of this study, as well as the previous one by these authors, demonstrate that greater annoyance, lower sleep quality, lower levels of “human restoration” from sleep, and negative emotions are related to increasing IWT noise.

C. E. Pedersen and P. Larsman, “The impact of visual factors on noise annoyance among people living in the vicinity of wind turbines,” *Journal of Environmental Psychology*, 28, 2008, pp. 379-389.

32. This paper combines the survey data sets from the two Pedersen and Waye articles (2004, 2007) discussed above. The authors develop a more nuanced multi-equation model which tests for the measured impact of noise (audible and inaudible) upon respondents’ propensity toward being annoyed and the simultaneous relationship between annoyance and attitudes toward the visibility of the turbines.

33. Citing a 1995 research effort, the paper’s first sentence notes that “[c]ommunity noise is an increasing environmental problem known to cause adverse health effects.” Pedersen and Larsman continue, citing the previous two Pedersen and Waye articles, “Wind turbines are new sources of community noise and their impact on people living nearby are as yet only partly known. ... Dose–response relationships between A-weighted sound pressure levels (SPLs) and noise annoyance with wind turbine noise were verified in these studies, even though the noise levels from wind turbines were low, typically being below 40 A-weighted decibel (dB(A)) outside the dwellings of respondents.”¹⁶

34. They ask the question: *Why are people annoyed by IWTs at much lower dBA than other forms of community noise (See Figure 1 above)?* In trying to answer this question, they noted perhaps the visual impact of the wind turbines interacted with the response to turbine noise. Respondents living in the proximity of wind turbines talked primarily about the noise, but also about the spoiled view and the constant movement of the rotor blades always attracting the eyes. This has since been labeled “flicker” and is claimed to be an adverse effect, much like living with a strobe light going on continuously, when the sun is at the right angle to catch the spinning of the blades. In any case, they specified a model to quantify the visual impact of the IWTs upon a

¹⁶ Quotes in this paragraph are from p. 380.

respondent's "Visual Attitude." They then attempted to differentiate the impacts of "Visual Attitude" from the impacts of the noise itself, hypothesizing that people were measured as being more sensitive to IWT noise at lower dBA because they could also see the looming behemoth of an IWT and suffer from its flicker, in addition to the noise.

35. As they talked with the survey respondents, they found that an adverse response to IWT noise was *positively correlated with noise* (A-weighted SPL); *positively correlated with negative general attitudes* toward IWTs; and *positively correlated with Visual Attitude toward the specific local IWT* they could see. However, correlation is not causation. The problem with the modeling effort is that all of the proposed factors are correlated and it is unclear what causes what. Even when the authors allow all three factors to have an independent effect on annoyance, *noise still had a positive and statistically significant effect*. This is remarkable, as a statistical result, since the three variables are quite collinear. It is well known that when such multi-collinearity exists, it is difficult to identify with statistical precision the independent effects of the multi-collinear variables.

36. Unfortunately, their model and data are incapable of distinguishing causality from correlation. Do all three factors have independent effects? Or does one factor cause annoyance and the other factor? For example, if I live very close to an IWT and it looms mightily above my home and I am suffering from the adverse effects of the noise I hear and feel (for the sub-audible range), I will certainly have a negative Visual Attitude toward the proximate IWT; I will certainly see the IWT clearly (line-of-sight improves noise dispersion); I will certainly develop generally negative attitudes toward IWTs. So, if true, it is the noise itself that causes the other two attitudes to be more negative; which in turn can be found to have a measureable effect on annoyance. When all three variables are included in a regression, they may appear to display separate effects, and the measured effect of each will be less than if the entire effect was due to, and recognized as due to, the adverse response to noise (audible and inaudible).

37. The authors understand this: "The *proposed model was based on* theoretical assumptions about causality and on *the assumption that attitude towards the source influences noise annoyance*.¹⁷ However, we cannot exclude the possibility that the causality is directed the opposite way so that annoyance causes a negative attitude towards the source. Being annoyed by wind turbine noise in the home environment could initiate a negative attitude towards wind turbines. There may also be a feedback loop between these variables." *After considering these possibilities of correlation and*

¹⁷ Specifically, one may just hate IWTs altogether, for whatever reason. In that case, one's general negative general attitude will certainly cause one to have a negative Visual Attitude to the specific IWT one sees and will predispose one to be annoyed by the noises heard. In that case, the negative general attitude is the main causal factor.

*causation, the authors conclude that “noise immission [sic] levels are possibly still the best predictor of noise annoyance.”*¹⁸

D. E. Pedersen, F. van den Berg, R. Bakker and J. Bouma, “Response to noise from modern wind farms in The Netherlands,” *Journal of the Acoustical Society of America*, 126(2), August 2009, pp. 634–643.

38. These authors begin their 2009 paper stating:¹⁹

“Community noise is recognized as an environmental stressor, causing nuisance, decreased wellbeing, and possibly non-auditory adverse effects on health. The main sources of community noise are transportation and industry. Air transport is the most annoying of the dominant means of transport. ... Increasing awareness of the adverse effects of noise has led to noise management recommendations, including [World Health Organization – WHO] guideline values to limit health effects in various situations and action plans for reducing noise and preserving quietness, all with the aim of decreasing the overall noise load. Noise impact is quantified based on the relationship between noise dose and response, the latter measured as the proportion of the public annoyed or highly annoyed by noise from a specified source.”

“Wind turbines are a new source of community noise to which relatively few people have yet been exposed. The number of exposed people is growing, as in many countries the number of wind turbines is rapidly increasing. The need for guidelines for maximum exposure to wind turbine noise is urgent: While not unnecessarily curbing the development of new wind farms, it is also important to avoid possible adverse health effects.”

39. As do the previous 3 papers, this paper estimates and finds a statistically significant positive dose-response relationship between A-weighted sound pressure levels and reported perception of and annoyance from the noise in a 2007 field study in The Netherlands in which 725 respondents participated. The same survey questionnaire used in the Swedish studies was used here. As in Pedersen and Waye (2004; Figure 1 above), wind turbine noise was found more annoying than transportation noise or industrial noise at comparable levels, possibly due to specific sound properties such as a “swishing” quality, temporal variability, and ***lack of nighttime abatement***, which of course causes

¹⁸ Quotes in this paragraph are from p. 388.

¹⁹ P. 634.

sleep disruption. “Response to wind turbine noise was similar to that found in Sweden so the dose-response relationship should be generalizable.”²⁰

40. They note that there have been only a few studies measuring IWT dose-response relationships,²¹ which have found the following evidence. The sizes and heights of IWTs have increased over time; this is important since the evidence suggests that annoyance and sleep disorders increase with the size of the IWTs. Wind turbines differ in several respects from other sources of community noise. Specifically, modern IWTs mainly emit noise from turbulence at the trailing edge of the rotor blades. The turbine sound varies with the wind speed at hub height and varies rhythmically and more rapidly as the sound is amplitude-modulated, due to the variation in wind speed. Amplitude-modulated sound is more easily perceived than is constant-level sound and has been found to be more annoying. This is particularly true when turbines are placed in open rural areas with low levels of background sound.

41. The authors find the following analytic results.

- The degree of perception and annoyance increased with increasing sound level, for both outdoor and indoor annoyance. The proportion of respondents who were annoyed (rather or very) by the sound increased with increasing sound level up to 40–45 dB(A).
- The proportions of respondents annoyed by wind turbine noise were comparable to the previous Swedish studies.²² However, “this study found a stronger relationship between immission [sic] levels of wind turbine noise and annoyance than the ... Swedish studies,”²³ which may be due to the larger wind turbines included in the present study. Higher towers push the rotors to heights with stronger winds, increasing the time a wind turbine operates and increasing differences between emission levels and the background ambient sound levels, especially at night.
- The probability of being annoyed by wind turbine sound was higher if wind turbines were visible rather than not. Again, since the annoying audible and inaudible sounds produced by IWTs will increase with line-of-sight prevalence, this finding is not surprising.

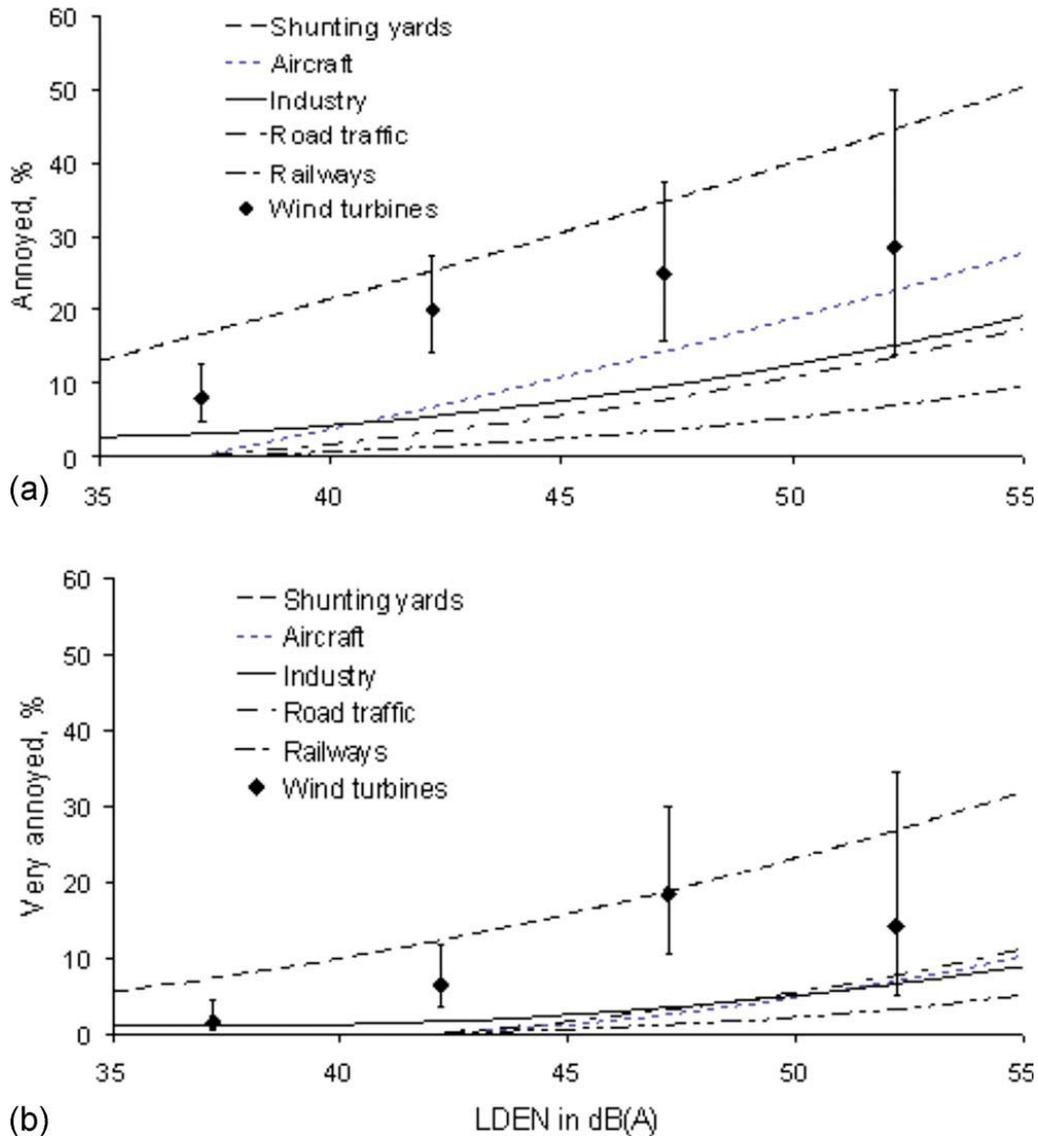
²⁰ P. 634.

²¹ See p. 635 which cites a European study carried out in Denmark, The Netherlands and Germany in 1993; a complementary Danish study carried out in 1994; and the Swedish studies discussed in Sections III. A-C above.

²² See Figure 2 on p. 640. Also see p. 642 and Sections III.A-III.C above.

²³ P. 642.

Figure 2
Proportion of Respondents Annoyed (a) and Very Annoyed (b) by IWT Noise
Compared to the Noise from Road Traffic, Aircraft and Railways
(Miedema and Oudshoorn (2001) and from Industry and
Shunting Yards (Miedema and Vos (2004))



- Figure 2 above presents the proportion of respondents annoyed and highly annoyed with wind turbine noise above 35 dBA and below 55 dB(A). It is larger than the proportion annoyed with noise levels from *all other noise sources except*

railroad shunting yards, at comparable Lden.²⁴ Shunting yards are rail yards in which trains and train cars are moved back and forth; connected, disconnected and reconnected; at random intervals; creating significant time-variant noise. The percentage of people “annoyed” or “very annoyed” with noise created at shunting yards is significantly higher than railway noise itself.

- “... the relatively high annoyance with shunting yard noise has partly been explained by the impulsive nature of some yard activities.²⁵ Wind turbine sound also varies unpredictably in level within a relatively short time span, i.e., minutes to hours. It can be postulated that it could be even more important that *neither type of noise ceases at night*. In contrast, in areas with traffic noise and/or industrial noise, background levels usually return to lower levels at night, *allowing residents to restore themselves psycho-physiologically*. A large proportion of respondents in the present study reported *hearing wind turbine sound more clearly at night*, an observation supported by previous findings. ... *Taken together, this implies that nighttime conditions should be treated as crucial in recommendations for wind turbine noise limits.*”²⁶

E. D. Shepherd, D. McBride, D. Welch, K.N. Dirks and E.M. Hill, “Evaluating the impact of wind turbine noise on health-related quality of life,” *Noise Health*, 13 (54), September-October 2011, pp. 333–339.

42. This paper reports on the analysis of a 2010 cross-sectional survey conducted in New Zealand under the guise of a “*Well-being and Neighbourhood Survey*,” named to mask the true intent of the study. That intent was to analyze and measure the health-related quality of life (HRQOL) of individuals residing in the proximity of a wind farm relative to those individuals residing in a demographically matched area sufficiently displaced from wind turbines (the control group).²⁷ The survey was in principle similar to the surveys discussed in the previous 4 papers. However, in designing the survey instrument, the authors considered a variety of outcome measures to assess the noise impacts including annoyance (used above), sleep disturbance, cardiovascular disease, cortisol levels and the subjective appraisal of health-related quality of life (HRQOL). The HRQOL is a concept that measures general well-being and well-being in the

²⁴ This is a reproduction of their Figure 3, p. 641. Lden is a dBA-based noise exposure level (den=day-evening-night) metric that has been found most appropriate for these analyses; see p. 634.

²⁵ See Miedema, H. and Vos, H., “Noise annoyance from stationary sources: Relationships with exposure metric day-evening night level (DENL) and their confidence intervals,” *Journal of Acoustical Society of America*, 2004.

²⁶ P. 642.

²⁷ Samples were drawn from two demographically matched areas differing only in their distances from a wind farm in the Makara Valley, a coastal area 10 km west of New Zealand’s capital city, Wellington.

physical, psychological, and social domains. Because changes in HRQOL are expected to closely co-vary with changes in health, the World Health Organization (WHO) recommends the use of HRQOL measures as an outcome variable.²⁸

43. Statistically significant differences were found in some HRQOL scores, with residents living within 2 km of a turbine installation reporting lower overall quality of life, physical quality of life, and environmental quality of life. Those exposed to turbine noise also reported significantly lower sleep quality, and rated their environment as less restful.

44. The authors conclude the following:²⁹

- “Our data suggest that wind farm noise can negatively impact facets of HRQOL.”
- A large proportion of respondents from the turbine group identified turbine noise as a problem and rated it to be extremely annoying. The authors state that “*It should be noted that, in contemporary medicine, annoyance exists as a precise technical term describing a mental state characterized by distress and aversion, which if maintained, can lead to a deterioration of health and well-being.* A Swedish study [Pedersen and Waye (2007)] reported that, for respondents who were annoyed by wind turbine noise, feelings of resignation, violation, strain, and fatigue were statistically greater than for respondents not annoyed by turbine noise.”
- “We also observed lower sleep satisfaction in the turbine group than in the comparison group, a finding which is consistent with previous research. One study directly related to wind turbine noise reported that 16% of respondents experiencing 35 dB(A) or more of noise suffered sleep disturbances due to turbine noise [Pedersen and Waye (2004)]. Another study investigating the effects of wind turbine noise on sleep showed that 36% of respondents who were annoyed at wind turbine noise also reported that they suffered disturbed sleep (versus 9% of those not annoyed). A case-study approach examining exposure to turbine noise likewise identified turbine noise as an agent of sleep disturbance [a study for the WHO]. In relation to turbine noise levels, one study reported that even at the lowest noise levels (≈ 25 dB(A)), 20% of respondents reported disturbed sleep at least one night per month, and that interrupted sleep and difficulty in returning to sleep increased with calculated noise level. Demonstrably, our data have also captured the effects of wind turbine noise on sleep, reinforcing previous studies

²⁸ The authors cite scientific evidence linking community noise to health problems. The WHO reports that chronic noise-induced annoyance and sleep disturbance can compromise health and HRQOL (see p. 334 for the citations).

²⁹ Pp. 333, 337-338.

suggesting that the acoustic characteristics of turbine noise are well suited to disturb the sleep of exposed individuals.”³⁰

IV. Summary and Conclusions

45. I conclude the following.

- a) The “Independent Expert Panel” convened by the Mass DEP and the Governor was not independent. This fact alone is enough to disqualify it as a source of unbiased objective scientific opinion. Given the background of the participants and their advocacy connections to Big Wind, this Panel has produced a document designed to be advocacy, not science.
- b) The “Independent Expert Panel” was not sufficiently expert to peremptorily dismiss or marginalize existing research performed by experts in their relevant areas, research which contradicts the findings of the Panel. The qualifications of the Panel members are certainly no better and in many cases worse than the qualifications of the scientists whose work they dismiss. This dismissal appears to be nothing less than eliminating inconvenient truths about the adverse health impacts of IWTs.³¹
- c) The “Independent Expert Panel” conducted no independent scientific research, even though many sample populations for estimating dose-response models in a before-and-after context were available to it. These sites include IWTs being erected or having been erected in Massachusetts and New England generally. Since the dispersion and potential adverse impacts of noise from IWTs are influenced by the topography and the ambient noise levels of the local areas in which they are sited, these local sites provide better estimates of potential adverse health impacts than sites in Europe and New Zealand. Indeed, at many of the sites at which IWTs already have been erected, there have been substantial adverse impacts.³² If the Governor and the Mass DEP are actually concerned

³⁰ A complete set of references is found on pp. 337-338.

³¹ The advocates of IWTs like to dismiss reports of adverse effects as a “nocebo effect;” that is, an adverse effect that is imagined by the reporting residents. This dismissal is nonsense. As the articles relied upon by the Expert Panel (and many dismissed by the Panel), industrial noises have adverse impacts on the quality of life and health. Go ask someone living near Logan airport whether their sleep is disturbed or they are annoyed by incoming and outgoing jets. That is why there are timing restrictions on the operation of Logan Airport.

I note that the research relied upon by the Panel finds that local residents report IWT noise much more annoying and a much greater sleep disrupter than air traffic. Does the Panel expect us to believe that jet noise and IWT noise are all imagined by local residents? Apparently they do.

³² For examples, Falmouth, Fairhaven, Vinalhaven and now Hoosac.

about adverse impacts of IWTs, they should be paying closer attention to these sites and pause their aggressive efforts to get IWTs sited, until these adverse effects are better understood. I see no evidence of that occurring.

- d) The Panel comes to some very strong conclusions which are simply contradicted by the research they cite as reliable. They are certainly contradicted by the research they improperly dismiss. In sum, the Panel's unsupported conclusions, presented in ¶ 19, are that there is limited evidence that IWTs annoy neighbors; that the annoyance may really be due to seeing the IWTs rather than the noise they make; there is limited evidence that IWTs cause sleep disruption; and there is no evidence that the noise emission from IWTs have adverse health effects.

46. If the results of this Wind Turbine Health Impact Study were not given such widespread credence, these assertions would be comical, given the evidentiary record. Unfortunately, public policy affecting peoples' lives is being determined based upon these conclusions. Most of the research that the Panel dismissed contradicted the Panel's assertions. Their dismissal of this research is unacceptable as a matter of scientific procedure. However, even the research that the Panel allowed to be introduced contradicts their conclusions. I have developed this fact above in Section III.

47. Had the Panel not misrepresented the conclusions of the five studies they cite, the Panel's conclusions would have been similar to those of the studies cited. In this Summary, I reiterate just a few of these findings which are in stark contrast to those unsupported findings of the Panel:³³

- “A statistically significant dose–response relationship was found, ***showing higher proportion of people reporting perception and annoyance than expected from the present dose–response relationships for transportation noise.***”³⁴
- The percentage of the population ***highly annoyed*** increased much more rapidly than other forms of transportation, reaching 35-40% at 40-42 dBA, that is, ***before the other forms of noise (even aircraft at airports) even register annoyance.***³⁵ One can conclude that, for some reason, the proportions of respondents annoyed by wind turbine noise are higher than for other community noise sources at the same A-weighted SPL and that the proportion annoyed increases more rapidly.

³³ The following include direct quotes (which are in quotation marks), some paraphrasing, or description of figures.

³⁴ See Section III.A above.

³⁵ This is a description of Figure 1 above.

At sound category 37.5–40.0 dBA, “20% of the 40 respondents living within this exposure were very annoyed and above 40 dBA, 36% of the 25 respondents.”³⁶

- “When adding the subjective factor of attitude to visual impact as an independent variable, the influence of the noise exposure decreased, but was still statistically significant.”³⁷
- “Most respondents who were annoyed by wind turbine noise stated that *they were annoyed often, i.e., every day or almost every day*. ... the noise intrudes on people’s daily life.” ... “Some of the respondents also stated that they were disturbed in their sleep by wind turbine noise, and the proportions seemed to increase with higher SPL.”³⁸
- “[N]oise annoyance was associated with sleep quality and negative emotions.” Of those respondents who were annoyed by wind turbine noise, 36% reported that their sleep was disturbed by a noise source. ... Respondents who were annoyed by wind turbine noise felt more tired and tense in the morning. They also felt resigned (29%), violated (23%), strained (19%) and tired (19%) when thinking about wind turbines to a statistically significantly higher degree compared with those who were not annoyed.³⁹
- “Annoyance was associated with ... lowered sleep quality and negative emotions” ... which could “lead to hindrance of human restoration.” This, together with reduced restoration possibilities may adversely affect health.⁴⁰
- “[C]ommunity noise is an increasing environmental problem known to cause adverse health effects.”⁴¹
- After considering the possibility that noise, visibility of IWTs and attitudes toward IWTs may be correlated and together act to determine the stated adverse impacts of noise, the authors conclude that “noise immission [sic] levels are possibly still the best predictor of noise annoyance.”⁴²

³⁶ See Section III.A above.

³⁷ *Ibid.*

³⁸ *Ibid.*

³⁹ See Section III.B above.

⁴⁰ *Ibid.*

⁴¹ See Section III.C above.

⁴² *Ibid.*

- ***“Community noise is recognized as an environmental stressor, causing nuisance, decreased wellbeing, and possibly non-auditory adverse effects on health.”***⁴³
 - “The main sources of community noise are transportation and industry. Air transport is the most annoying of the dominant means of transport.”
 - IWT noise is found to be considerably more intrusive and annoying than air transport.
 - The proportion of respondents annoyed and highly annoyed with wind turbine noise above 35 dBA and below 55 dB(A) is larger than the proportion annoyed with noise levels from ***all other noise sources except railroad shunting yards***, at comparable Lden. Shunting yards are rail yards in which trains and train cars are moved back and forth; connected, disconnected and reconnected; at random intervals; creating significant time-variant noise. The percentage of people “annoyed” or “very annoyed” with noise created at shunting yards is significantly higher than railway noise itself.⁴⁴
 - “... the relatively high annoyance with shunting yard noise has partly been explained by the impulsive nature of some yard activities. Wind turbine sound also varies unpredictably in level within a relatively short time span, i.e., minutes to hours. ... It can be postulated that it could be even more important that ***neither type of noise ceases at night***. In contrast, in areas with traffic noise and/or industrial noise, background levels usually return to lower levels at night, ***allowing residents to restore themselves psychophysiological***. A large proportion of respondents in the present study reported ***hearing wind turbine sound more clearly at night***, an observation supported by previous findings. ... ***Taken together, this implies that nighttime conditions should be treated as crucial in recommendations for wind turbine noise limits.***”
- “Increasing awareness of the adverse effects of noise has led to noise management recommendations, including [World Health Organization – WHO, 2000] guideline values to limit health effects in various situations and action plans for reducing noise and preserving quietness. ... Wind turbines are a new source of community noise to which relatively few people have yet been exposed.”⁴⁵

⁴³ See Section III.D above for this bullet and its sub-bullets.

⁴⁴ This sub-bullet is an explanation of Figure 2 above in Section III.D.

⁴⁵ See Section III.D above.

- The proportions of respondents annoyed by wind turbine noise were compared with similar data from two previous Swedish studies. However, “***this study found a stronger relationship between immission [sic] levels of wind turbine noise and annoyance than the Swedish studies,***” which may be due to the larger wind turbines included in the present study.⁴⁶
- The probability of being annoyed by wind turbine sound was higher if wind turbines were visible rather than not. Since the annoying audible and inaudible sounds produced by IWTs will increase with line-of-sight prevalence, this finding is not surprising.⁴⁷
- A large proportion of respondents from the turbine group identified turbine noise as a problem and rated it to be extremely annoying. The authors state that “***It should be noted that, in contemporary medicine, annoyance exists as a precise technical term describing a mental state characterized by distress and aversion, which if maintained, can lead to a deterioration of health and well-being.*** A Swedish study reported that, for respondents who were annoyed by wind turbine noise, feelings of resignation, violation, strain, and fatigue were statistically greater than for respondents not annoyed by turbine noise.”⁴⁸
- “We also observed lower sleep satisfaction in the turbine group than in the comparison group, a finding which is consistent with previous research.” “Demonstrably, our data have also captured the effects of wind turbine noise on sleep, reinforcing previous studies suggesting that the acoustic characteristics of turbine noise are well suited to disturb the sleep of exposed individuals.”⁴⁹

Raymond S. Hartman
July 9, 2013

⁴⁶ *Ibid.*

⁴⁷ *Ibid.*

⁴⁸ See Section III.E above.

⁴⁹ *Ibid.*

Attachment A.1

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Curriculum Vita

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DEGREES

B.A. (MAGNA CUM LAUDE) Princeton University 1969
M.S. Massachusetts Institute of Technology 1971
Ph.D. Massachusetts Institute of Technology 1977

Ph.D. DISSERTATION

An Oligopolistic Pricing Model of the U.S. Copper Industry (MIT, 1977)

HONORS, SCHOLARSHIPS, AND FELLOWSHIPS

1969-71 National Science Foundation Fellowship to MIT
1965-69 Alfred P. Sloan Scholarship to Princeton
1969 Woodrow Wilson Fellowship Honorable Mention
1965 National Merit Scholarship Finalist

RESEARCH AND TEACHING INTERESTS

Econometrics/Statistics
The Economics of Regulated Industries
Energy and Environmental Economics
Microeconomics
Industrial Organization
Law and Economics

POSITIONS

1967-1969 Research Staff, Financial Research Center and Center for Economic Research, Princeton University
 1970 Research Staff, Board of Governors, Federal Reserve Board, Washington, DC
 1972-1992 Consultant and Staff Economist, Arthur D. Little, Inc.
 1977-1984 Research Faculty, Massachusetts Institute of Technology
 1977-1983 Assistant Professor, Department of Economics, Boston University
 1983-1989 Associate Professor, Department of Economics, Boston University
 1983-1988 Principal & Academic Principal, The Analysis Group
 1988-1993 Visiting Associate Professor/Visiting Faculty, Boalt School of Law, University of California, Berkeley
 1988-1995 Founding Principal, The Law and Economics Consulting Group
 1995-1996 Vice President, Charles River Associates
 1996-1999 Senior Consultant, Charles River Associates
 1996-2000 Director, Cambridge Economics, Inc.
 2000-2004 Special Consultant, Lexecon Inc.
 1997- Director and President, Greynock McKinnon Associates

OTHER PROFESSIONAL ACTIVITIES

Research Referee, *Bell/Rand Journal of Economics, Resources Policy, IPC Science and Technology Press, Management Science, Land Economics, Science, Energy Journal, Applied Economics, Econometrica, Review of Economics and Statistics, Journal of Business and Economic Statistics, International Economic Review, Journal of Economics and Management Strategy, Pakistan Journal of Applied Economics, Journal of Health Economics, American Economic Review, Review of Industrial Organization*

PAPERS APPEARING IN OR BEING SUBMITTED FOR PUBLICATION IN REFEREED JOURNALS AND BOOKS

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"Welfare Measures in Discrete Choice Markets"

"The Nature of Pharmaceutical Competition and the Implications for Antitrust Analysis under the Hatch-Waxman Act," with Richard Frank

CONFERENCE PAPERS AND PRESENTATIONS

"Policies To Maximize Economic Growth In Japan," in Foreign Experience with Monetary Policies to Promote Economic and Social Priority Programs, Committee on Banking and Currency, 92nd Congress, Washington, May, 1972.

Comments on "Economic Models of Choice and Utilization of Energy -Using Durables" by D.

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"Market Penetration of Energy Technologies," talk given in the Boston University 1980 Spring Lecture Series, "Man and Energy: Energy and Regional Growth," 1979.

"Discrete Consumer Choice among Alternative Fuels and New Technologies for Residential Energy Using Appliances," MIT Energy Laboratory Working Paper, #MIT-EL-79-049WP, August, 1979. Paper given at the TIMS/ORSA Meetings, "Market Penetration Assessment of New Energy Technologies," May 4-7, 1980, and at the MIT Industrial Liaison Program, "The Future Demand for Energy," March 18, 1980.

"Department of Energy Residential Appliance Efficiency Standards-An Overview," Papers and Proceedings, Second Annual North American Meeting of the International Association of Energy Economists, October 1980.

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"Measuring the Impact of Utility Residential Conservation Programs: Two Case Studies," with S. Braithwait and M. Doane. Paper presented in the Electric Power Research Institute National Symposium Proceedings, Annual Review of Demand and Conservation, Atlanta, May 1984, and Buildings and Their Energy Systems, St. Louis, October 1984.

"Measuring Program-Induced Energy Savings: A Comparison of Alternating Methods," with M. Doane, in Electric Power Research Institute National Symposium Proceedings, Energy Expo 1985: Meeting Energy Challenges, Peragon Press.

"Taking the Con Out of Conservation Program Evaluation." Paper presented at "Energy Conservation Program Evaluation," Argonne National Laboratory Conference, Chicago, August, 1985, and at the Eighth Annual North American Conference of the International Association of Energy Economists, MIT, Cambridge, November 1986.

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"Product Emulation Strategies in the Presence of Reputation Effects and Network Externalities: Some Evidence from the Minicomputer Industry," with D. Teece. Paper presented at National Bureau of Economic Research, Conference on Productivity Measurement, July, 1987, and Stanford Center for Economic Policy Research Conference on Compatibility Standards and Information Technology: Business Strategy and Public Policy Issues, February 1989.

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presented at the Session on Postal Economics, American Economic Association Meetings, Washington D.C., January 7, 1995.

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MASSACHUSETTS INSTITUTE OF TECHNOLOGY (MIT); ANALYSIS GROUP, INC., (AG); LAW AND ECONOMICS CONSULTING GROUP (LECG); AND ARTHUR D. LITTLE, INC., (ADL) REPORTS

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AG, Customer Outage Costs and the Value of Service Reliability: Draft Analysis Plan for Residential and Large Commercial/ Industrial Customers, Draft Report prepared for the Niagara Mohawk Power Corporation, August 1988.

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LECG, Optimal Plant and Firm Size in the Electric Power Industry : Report on Academic/Industry Literature, Report to the Division of Ratepayer Advocates, California Public Utility Commission, August, 24, 1989.

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LECG, Report on the Proposed Merger of the Southern California Edison Company and the San Diego Gas and Electric Company -Surrebuttal: Econometric Analysis of Merger Impacts, Report to the California Public Utilities Commission, Division of Rate Payer Advocates, Application 88-12-035, July, 1990, Exhibit 10,511.

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Hartman, "A Critical Review of the Delmarva 1981-2000 Load Forecast," with James C. O'Keefe, Arthur D. Little Working Paper, September 1981, Arthur D. Little, San Francisco.

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"An Examination of the Use of Probability Modeling for the Analysis of Inter-fuel Substitution in Residential Fuel Demand," with M. Hollyer, MIT Energy Lab Working Paper #MIT-EL-77-018WP, July 1977.

"A Critical Survey of Three Copper Industry Models and Their Policy Uses," MIT Energy Lab Working Paper #MIT-EL-77-028WP, September 1977.

"The Evolutionary Model of Technical Change: Historical Evidence from Great Britain and the United States," with D. Wheeler, mimeo, December 1977.

"A Critical Review of Single Fuel and Interfuel Substitution Residential Energy Demand Models," MIT Energy Laboratory Report #MIT-EL-78-003, March 1978.

"A Generalized Logit Formulation of Individual Choice," MIT Energy Laboratory Working Paper #MIT-EL-79-010WP, February 1979.

"A Model of Residential Energy Demand," MIT Energy Laboratory Working Paper, #MIT-EL-79-041WP, August 1979.

"The Incorporation of Solar Photovoltaics into a Model of Residential Energy Demand," MIT Energy Laboratory Working Paper #MIT-EL 80-014WP, May 1980.

"Consumer Choice Among Alternative Fuels and Appliance Technologies: An Analysis of the Effects of Alternative Energy Conservation Strategies," MIT Energy Laboratory Working Paper #MIT-EL 82-036WP, June 1982.

"Estimation of Hedonic Supply Curves For Residential Water Heaters Using Technical Data and Federal Testing Guidelines," with Alan Cox and Mary Litterman, MIT Energy Laboratory Working Paper #MIT-EL 82-037WP, June 1982.

"A Monte Carlo Examination of the Heckman and the Manski-Lerman Estimators in Discrete/Continuous Models of Demand," October 1986.

"The Value of Service Reliability: Alternative Welfare Measures," with C.K. Woo, October, 1988.

"The Use of Hedonic Analysis in Defining and Measuring Market Size: The Extension of the Merger Guidelines to Heterogeneous Products," Working Paper No. 91-12, Program in Law and Economics. School of Law, Boalt Hall

EXPERIENCE IN CONSULTING AND EXPERT TESTIMONY

Overview of Qualifications

Dr. Hartman is an economist specializing in microeconomics, econometrics and the study of industrial organization. Microeconomics is the science used to analyze and characterize the behavior of groups of consumers and producers that constitute markets. Econometrics is a science that makes use of mathematics and statistics to measure and quantify economic behavior and economic phenomena in markets. The study of industrial organization makes use of both microeconomic theory and econometrics. It focuses upon the structure, conduct and performance of the participants (consumers and producing firms) in markets and industries, for the purposes of predicting behavior and addressing such policy issues as antitrust, regulation and industrial policy.

He has taught economics, conducted economic research and provided economic consulting in his areas of specialization for thirty-five years. He taught economics as an Assistant Professor and Associate Professor within the Department of Economics at Boston University over the period 1977-1988. He taught economics as a Visiting Associate Professor and member of the Visiting Faculty at the School of Law, Boalt Hall, University of California at Berkeley over the period 1988-1993. He was a member of the research faculty at MIT over the period 1977-1982, during which time he conducted research in energy markets for the United States Department of Energy. During the same time, he declined the offer of a Visiting Assistant Professorship within the Department of Applied Economics at MIT, and instead lectured on a selective basis. Since 1971, he has consulted to federal and state governmental bodies, private corporations, law firms, consulting companies, research organizations and international lending organizations. He has been and continues to be a research referee for a variety of academic journals, including the top academic journals in the country. He is the author of more than 100 refereed journal articles, book chapters and research/consulting reports.

He has submitted oral and written testimony before federal and state courts of law and regulatory commissions. His testimony as an expert witness has addressed anticompetitive behavior, merger efficiencies, breach of contract, employment discrimination, patent infringement, class certification and the estimation of damages in a variety of markets and industries including, but not limited to, the pharmaceutical industry, the health care services industry, the electric power industry, the banking industry, the agrochemical industry, the copper industry, the defense industry, the cable TV industry, the tobacco industry, the electrical and mechanical carbon products industry, the medical devices industry and the construction industry. He has consulted to counsel on litigation matters in a broader array of markets.

While his experience has been broadly-based across industries, two industries/markets have been primary subjects of substantial consulting, research and litigation support.

Experience in Energy Markets and Regulated Industries

Since 1977, Dr. Hartman's expertise and experience have involved regulated industries generally and the markets for electric power and natural gas specifically. His consulting and/or litigation assignments

have included load forecasting, evaluation of conservation and load management programs, econometric cost analysis, analysis of revenue requirements and rate-making, analysis of value of service reliability the analysis of mergers and acquisitions, analysis of industry restructuring, analysis of manipulation of spot and future prices in energy markets, and analysis of contract damages arising from DOE's partial breach of the Standard Contract regarding storage of spent nuclear fuel waste. In these assignments, Dr. Hartman has consulted for such clients as Arizona Public Service, the Pacific Gas and Electric Company, the Southern California Edison Company, the Southern California Gas Company, the San Diego Gas and Electric Company, Portland General Electric Company, Bonneville Power Administration, General Public Utilities, Northeast Utilities, Niagara Mohawk Power Corporation, the Delmarva Power Corporation, Florida Power Corporation, Site Energies, the California Energy Commission and Public Utilities Commission, the Missouri Public Service Commission, the Rhode Island Division of Public Utilities, the Attorney General of the State of Massachusetts, the Electric Power Research Institute, the Gas Research Institute, the U.S. Department of Energy, the U.S. Department of Justice, the World Bank, and the governments of Indonesia and Thailand. He has consulted for a number of other clients whose identity must remain confidential. Over the last five years, he has testified numerous times before the United States Court of Federal Claims on behalf of the DOJ and DOE with regard to damages caused by DOE's partial breach of the Standard Contract.

Experience in Health Care and Pharmaceutical Markets

Over the past 15 years, Dr. Hartman has participated as testifying or consulting expert in a wide array of matters related to health-care markets generally and, more specifically, markets for medical devices and pharmaceutical products. For examples, working with a team of health care experts, he submitted written testimony assessing and measuring the impacts of smoking on Medicaid health care costs in the Commonwealth of Massachusetts. He submitted testimony analyzing the competitive impacts upon and damages to a class of dental laboratories caused by the restrictive dealer practices of a dominant U.S. manufacturer of medical prostheses - false teeth. He consulted to the group of wholesaler defendants in the Brand-Name Prescription Drugs Antitrust Litigation, addressing issues of wholesaler pricing across classes of trade. He consulted to and/or submitted testimony for counsel to manufacturers of cardiovascular stents, related cardiovascular devices and generic drugs in a variety of patent infringement matters, addressing such issues as competition, market definition, liability, market penetration of new products and economic damages arising from patent infringement. He consulted for one group of private plaintiffs in the antitrust matter regarding the prescription drugs lorazepam & clorazepate and for the Federal Trade Commission in the matter of Hoechst Marion Roussel, Inc., Carderm Capital L.P. and Andrx Corporation concerning antitrust claims involving the prescription drug Cardizem CD. That consultation addressed issues of market definition, product competition, class certification and damage estimation. He consulted to counsel on the matter of damages to the class of direct purchasers of the prescription drugs Taxol and Flonase. He consulted to counsel and/or submitted testimony on the matter of damages to classes of indirect end-payer purchasers of the prescription drugs K-Dur, Augmentin, Wellbutrin, Zyprexa, Bextra, Celebrex, Tricor, Nexium, Estratest, Lotrel, Ketek, Flonase and Vioxx.

He submitted testimony addressing class certification, liability and/or damages for the class of end-payer purchasers in antitrust, state consumer protection or RICO litigation concerning the prescription drugs Hytrin, BuSpar, Relafen, Lupron, Premarin, Ditropan, the hormone replacement therapy Estratest, Cipro in the states of New York and California and in the United States, K-Dur, Neurontin in the United States and Pennsylvania, and Risperdal in the State of Louisiana. In the MDL AWP litigation, he submitted testimony in support of the certification of to the class of end-payer purchasers of those pharmaceutical products produced by AstraZeneca, the Bristol-Myers Squibb Group, the Johnson & Johnson Group, the GlaxoSmithKline Group and the Schering Plough Group that were alleged to have been the subject of a

scheme to fraudulently inflate their Average Wholesale Price (AWP); he subsequently submitted and presented at trial testimony supporting findings of causation, liability and the calculation of damages for those end-payer groups for which class certification was granted and upheld at the appellate level. He has consulted to and/or submitted testimony for the Offices of the Attorneys General for the states of Massachusetts, Texas, New York, Connecticut, Montana and Nevada in analogous matters. He submitted testimony addressing class certification, liability, damages and settlement allocation in the MDL litigation, *New England Carpenters Health Benefits Fund, et al, Plaintiffs, v. First Databank, Inc., a Missouri Corporation and McKesson Corporation, a Delaware Corporation, Defendants*, in which violations of U.S. RICO and state consumer protection statutes were allegedly violated. He submitted similar testimony addressing and calculating the economic damages of these alleged activities upon the Medicaid agency and other governmental agencies of several specific states. He submitted testimony regarding class certification in the MDL matter alleging ERISA violations, *In re Express Scripts, Inc., PBM Litigation*. He has consulted to drug companies on related matters when they have arisen in a patent litigation context. His testimony has been the basis for the certification of class in a variety of these matters. His testimony has been the basis for approval supporting settlement agreements in a variety of these and other pharmaceutical matters.

He has provided testimony and/or white papers for counsel used in arbitration for a hospital seeking to revoke surgical privileges for an allegedly incompetent thoracic surgeon and for an insurance company that alleged physicians were overcharging for services provided under Medicare.

Specific Assignments

1972-1975: In consultation with Arthur D. Little, Inc., Dr. Hartman developed economic impact models to assess the effects of environmental regulations upon the U.S. pollution abatement equipment industry and upon a particular U.S. copper smelting company.

1972-1975: In consultation with Arthur D. Little, Inc., Dr. Hartman developed economic models to assess the regional macroeconomic and industrial impacts of alternative strategies to promote tourism-related industries. The models were used in the United States by the states of Maryland and Maine and for the Philadelphia Bicentennial Commission. Internationally, the models were used by the Ministry of Planning of Mexico to assess the national and regional importance of tourism coming into Acapulco.

1976-1977: Consultation with Arthur D. Little, Inc. for the U.S. Environmental Protection Agency. The effort involved the design, estimation and implementation of an econometric simulation model that was used to assess the impact of pollution abatement legislation on the U.S. copper industry. The model was designed to incorporate engineering cost estimates attributable to the abatement legislation while accounting for the noncompetitive pricing behavior in the industry. The model was used to evaluate and revise proposed abatement legislation. This analysis was the basis for Dr. Hartman's Ph.D. dissertation and several of his publications.

1977-1982: Working as the testifying expert, Dr. Hartman analyzed the presence of a price-fixing conspiracy among the major U.S. copper producers during the 1970's. His testimony addressed issues of liability and developed a model of damages. See

Affidavit to United States District Court for the Southern District of New York, *J.N. Futia Co., Inc., Plaintiff, Against Phelps Dodge Corporation, et al., Defendants*, 78 Civ. 4547 (ADS), 1978.

Deposition for United States District Court, Southern District of New York for *Reading Industries, Inc., et al. (Plaintiffs) against Kennecott Copper Corporation, et al. (Defendants)*, 17 Civ. 1736

(MEL), 1982.

1979: Working for the California Energy Commission, Dr. Hartman developed and presented a Statement of Opinion and Critical Review of Selected Energy End-Use Models and Proposed Specifications for PG&E End-Use Modeling Efforts before the California Energy Commission Hearings on Utility Construction and Siting, November 26-30, 1979.

1984: Testifying expert for the class of all individuals who employed the services of members of Massachusetts Furniture and Piano Movers Association. The analysis developed an econometric model to assist in certifying the class and measuring the damages common to that class. See

Affidavit to United States District Court for the District of Massachusetts in the Matter of *Kenett Corporation et al v. Massachusetts Furniture and Piano Movers Association Inc. et al*, May 1984, Civil Action No. 82-140-Z.

1984-1986: In consultation with the U. S. Postal Service, Dr. Hartman identified appropriate econometric methods for analysis of the determinants of Postal Service costs. The particular methods he suggested were "hedonic" cost techniques, which are specifically designed to account for the fact that both increased levels of production and improved product attributes increase costs. The techniques assisted the Postal Service in quantification of the cost impacts of the attributes of service quality for alternative classes of service. For example, the techniques allowed for estimation of the differential cost impacts of alternative service priorities, size and weight attributes of the various classes of mail.

He later applied these techniques for a group of second class mailers. The analysis was introduced before the Postal Service Commission to assess whether proposed postal rate changes reflected actual costs.

1984-1986: The development of econometrically-based strategic planning models, which allow for estimation of the effects on corporate profits of alternative product design and pricing strategies. The models allow for examining specific design strategies by explicitly incorporating detailed product attributes. The models were developed for Westin Hotels and Shell Oil. The Westin models have been implemented into an interactive PC tool that facilitates pricing decisions at the front desk.

1985: For analysis presented before the International Trade Commission, Dr. Hartman helped develop and estimate a model to evaluate the domestic effects of importation of certain synthetic aramid fibers. The analysis was used in adjudicating an international patent infringement complaint.

1985-1986: Dr. Hartman participated in an analysis of one of the nation's largest mutual funds. The study was undertaken as part of a class action alleging inappropriate management fees. The study assessed competition in the money market mutual fund industry. It measured investors' sensitivity to changes in yield and to the level of services provided. It also statistically identified the determinants of the costs of providing mutual fund services.

1985-1986: The development for GTE Laboratories of econometric demand models for analysis and measurement of the determinants of demand for telecommunications services. The models explicitly address the separate customer decisions to subscribe to one of several telecommunications carriers and the demand for telecommunications services, conditional upon the subscription decision. The analysis was employed by GTE to assist their subsidiary, GTE Sprint, in the design of marketable services, where the services were differentiated by tariff, perceived service quality, provider reputation, and specialized customer services. The analysis is summarized in the paper

"Estimation of Household Preferences for Long Distance Telecommunications Carrier", *Journal of Regulatory Economics*, Volume 6, 1994.

1985-Present: Dr. Hartman has performed a variety of economic damage analyses in cases of personal injury, wrongful injury and wrongful death. He has worked for both plaintiff and defendant. He was last deposited in such matters in 1995.

1986: For a major natural gas pipeline, preparation of an analysis of the effects of natural gas deregulation as proposed in the Federal Energy Regulatory Commission's Notice of Proposed Rulemaking No. 436.

1986-1987: Working for the class of owners of selected General Motors' X Cars and VW Rabbits, Dr. Hartman specified and estimated economic models that assisted in the certification of class and estimation of class damages. The damages flowed directly from allegedly-concealed design flaws in these automobiles. The methods are described in

"The Use of Hedonic Analysis for Certification and Damage Calculations in Class Action Complaints," with M. Doane, *The Journal of Law, Economics and Organization*, Fall 1987.

1986-1987: Development of damage models for litigation in high technology industries. The models were developed in several cases. One involved alleged patent infringement by a major Japanese semiconductor firm, and the second involved market foreclosure of a domestic minicomputer emulator. In these efforts, Dr. Hartman developed economic models to estimate the market potential, absent the violation, for the particular product foreclosed or whose patent was infringed. The methods are described generically in

"Product Emulation Strategies in the Presence of Reputation Effects and Network Externalities: Some Evidence from the Minicomputer Industry," with D. Teece, *Economics of Innovation and New Technology*, Volume 1, 1990.

1987: Analysis of the competitive effects of relaxing the restrictions on the Bell Regional Operating Companies regarding their vertical extension upstream into equipment manufacture and downstream into the provision of selected telecommunication services. The study was introduced before Judge Greene in the triennial review of the divestiture of the Bell operating companies from AT&T.

1987-1988: For a major gas utility, participation in analysis of the economic effects arising if bypass of an existing pipeline were allowed by state and federal regulation. The analysis developed methods for assessing when competitive bypass is socially desirable. The analysis also developed and used an econometric model to simulate the effects of bypass on demand and prices.

1988: Analysis of the competitive effects the acquisition of trade secrets through the predatory hiring of a competitor's essential labor force. See

Analysis submitted in testimony in the case *Universal Analytics Inc. v. MacNeil Schwendler, Corp.*

1988-1989: As part of their proposed acquisition of Public Service of New Hampshire, Dr. Hartman was retained by Northeast Utilities, Inc. to develop and estimate load forecasting models. The models were used to assess the demand implications of alternative rate assumptions proposed as part of the acquisition.

The forecasts were introduced as part of Northeast Utilities' filings before the bankruptcy court, the state public utility commissions, the SEC and the FERC.

1989: As part of major antitrust litigation against the leading vendors of airline computer reservation systems, Dr. Hartman helped develop liability analysis and models for the estimation of damages.

1989: As a proposed testifying expert for ParnelliJones, Inc., Dr. Hartman analyzed the antitrust implications of Firestone's retail trade practices, particularly alleged vertical and horizontal restraints of trade. He designed damage models for the alleged violations.

1989 - 2000: Dr. Hartman performed the market analyses required for Hart-Scott-Rodino applications and second requests supporting mergers and acquisitions in a variety of industries, including specialty chemicals, airlines, health care and medical diagnostic products, and energy products and services.

1989-1990: Dr. Hartman participated as a principal investigator and testifying expert for the Division of RatePayer Advocates of the California Public Utility Commission in an analysis of the economic and legal implications of the proposed merger between Southern California Edison Company and San Diego Gas and Electric Company. Dr. Hartman's responsibilities included overall study design, econometric analysis of scale and scope economies arising with the merger, and analysis of efficiencies purportedly arising with the coordination of the demand-side management programs of the two utilities. His direct and surrebuttal testimony is found in

California Public Utilities Commission, Division of Rate Payer Advocates, Report on the Proposed Merger of the Southern California Edison Company and the San Diego Gas and Electric Company, Volume V, Chapter II, Application 88-12-035, February, 1990, Exhibit 10,500; and

California Public Utilities Commission, Division of Rate Payer Advocates, Report on the Proposed Merger of the Southern California Edison Company and the San Diego Gas and Electric Company, Surrebuttal: Econometric Analysis of Merger Impacts, Application 88-12-035, July, 1990, Exhibit 10,511.

1989-1990: Working with Arthur D. Little, Inc., Dr. Hartman participated as a principal investigator and testifying expert in a merger study for several small New England utilities within Nepool. Dr. Hartman designed and implemented a statistical study of returns to scale and scope in the industry. Using the statistical results, Dr. Hartman developed opinions regarding the efficiency effects of the proposed merger. His analysis appears as an independent Appendix to

Arthur D. Little, Inc., Evaluation of EUA's Proposed Acquisitions of UNITIL and Fitchburg, Report to Gaston and Snow, March 12, 1990, presented in support of the acquisition to the Securities and Exchange Commission and the New Hampshire Public Utilities Commission.

1990: Working for a group of commodity futures exchanges, Dr. Hartman participated as Principal Investigator in a critical review of a statistical and econometric study performed by the Commodity Futures Trading Commission. The CFTC study was developed to assess the effects of dual trading on commodity futures markets, in order to implement proposed regulations curtailing such trading.

1990: Working with Barakat and Chamberlin, Inc., Dr. Hartman developed a Ramsey pricing model for Arizona Public Service Corporation. The Ramsey pricing model was used to develop and

explore alternative rate strategies for a variety of residential, commercial and industrial market segments. The analysis was submitted in formal rate hearings.

1990-1992: Working with the Technology Research Center of Arthur D. Little, Inc. for the United States Postal Service, Dr. Hartman specified and estimated econometric models to analyze the determinants of productivity for the largest 120 post offices in the United States. The econometric models are being used to identify the most and least productive offices, with the purpose of learning from the performance of the most productive offices in order to improve the performance of the least productive offices. The models are being used to design and implement incentive regulation mechanisms to increase productivity across post offices.

A second set of econometric models have been specified and estimated to quantify the effects of the attributes of alternative postal services and rate classes upon total postal service costs. The results of this analysis are being used to design postal rates for alternative classes of service which reflect the real costs of providing the services. The analysis and its results will be introduced into the postal rate hearings.

1990-1997: Working with the World Bank, Dr. Hartman has specified and is estimating a set of econometric models to measure both the level and types of pollutants emitted by United States plants and establishments and the costs of abating those pollutants. The models identify and quantify, at the plant level, the relationship between the emission of approximately 300 pollutants and the scale of production, the types of technology used, the age and characteristics of the plant and equipment used, the extent to which abatement equipment has been installed, and the costs (capital and operating) of abating alternative pollutants.

The models will be used in the following ways in developing countries and Eastern European countries: to assist the countries to predict and assess the environmental implications of reliance upon certain technologies and industries in development; to assess the effectiveness of alternative regulatory methods for abating pollution, including effluent standards, effluent taxes, effluent licenses, technology standards, effluent banks, and alternative property right schemes; to implement incentive regulation mechanisms to better stimulate abatement compliance; and to identify and prioritize those industries that can abate certain pollutants at least cost.

As part of this effort, Dr. Hartman has also designed a specific incentive regulation system for pollution abatement compliance in Indonesia. The system is based upon the most recent theory in regulated incentive mechanisms. The system will ultimately evolve into an effluent bank or a system of effluent fees. If the effort is successful, it will form the basis for environmental institutions in other developing countries. In the process of designing this system, he has reviewed the institutional and statutory basis for environmental policy in Indonesia.

Also as part of this work, Dr. Hartman is in the process of designing the institutional and statutory structures for Environmental Protection Agencies in a variety of developing countries. The institutional structures will be designed to articulate and implement pollution abatement policies that are informed by the econometric modeling described above.

1991: Dr. Hartman participated as a principal investigator and testifying expert for the Missouri Public Service Commission in a critical analysis of the proposed merger between Kansas Power and Light Company and Kansas Gas and Electric Company. Dr. Hartman's responsibilities included overall study design, analysis of scale and scope economies arising with the merger, analysis of unanticipated transitional cost arising with the merger and an econometric event study of the stock market's response to the merger. His testimony appears in

A Critical Analysis of the Proposed Merger Between Kansas Power and Light Company and Kansas and Electric Company, Report to the Missouri Public Service Commission, March 25, 1991.

1991: Working for the Resolution Trust Corporation in its litigation against Michael Milken and Drexel Burnham Lambert Inc., Dr. Hartman developed data and econometric models to measure the size of the relevant antitrust markets dominated by Drexel and to estimate the size of the economic damages produced by Drexel's alleged monopolization of those markets.

1991-1992: Working for the Indonesian government and the United States Agency for International Development, Dr. Hartman critically reviewed the structure of the Indonesian electric power industry and the institutions regulating that industry. The purpose of the analysis was to assist the government with privatizing their energy industries. His analysis focused upon the following: developing better data and models for predicting demand and supply; identifying and implementing more efficient industrial structures; and developing better regulatory regimes.

1992: Working for the World Bank, Dr. Hartman designed methods to measure and compare the social value of the environmental effects of alternative development projects, at the microeconomic and macroeconomic levels. His analysis focused upon standard and contingent valuation survey approaches and their use in econometric settings.

1992-1993: Working for the World Bank in Bangkok, Dr. Hartman characterized and critically analyzed the environmental effects of Thailand's energy use patterns. He focused upon the use and production of electric power, petroleum, coal and natural gas. He developed recommendations for environmental policy changes that included, but were not limited to, fuel taxes, effluent standards, technology standards, and privatization of environmental monitoring within a "bubble" policy approach.

1992-1993: Working for a biomedical company (a producer of vascular grafts) in an antitrust situation, Dr. Hartman designed and implemented survey techniques and econometric models to measure the size of the relevant markets and market power within those markets.

1992-1993: In a proceeding before the International Trade Commission, Dr. Hartman critiqued ITC econometric methods used for estimating elasticities of demand, supply and substitution among domestic and imported products. His focus was selected steel products. He formulated and estimated alternative models and methods to improve the existing estimates. He developed presentation materials for the Commission and testified before the Commission. His testimony is included in

LECG, Petitioners' Economic Testimony in the Matter of Certain Carbon Steel Flat Products, Final Hearing before the United States International Trade Commission, June 29-30, 1993; and

LECG, Petitioners' Post Hearing Brief in the Matter of Certain Carbon Steel Flat Products, before the United States International Trade Commission, July 7, 1993.

1992-1997: Working for the World Bank, Dr. Hartman has designed and is currently implementing a set of regional econometric/engineering models that accurately portray and predict the economic, environmental, infrastructural and socio-demographic effects of large-scale, World-Bank-funded infrastructural projects. The models combine input-output and econometric methods.

Given the Bank experience that many of their financially -sponsored projects create significant

unanticipated environmental effects, the models are designed to be broad and comprehensive enough to incorporate and predict all important effects. The models systematically characterize the relationship between resource-based economic growth and the regional environment in which that growth occurs.

The models are currently being implemented for assessing project developments in the Carajas region of the Brazilian Amazonian rain forest, which is a large, dynamic and ecologically sensitive frontier area. The methods implemented for Brazil will be generalized for analysis of economic growth in ecologically similar areas, such as the Lake Baikal region of the former Soviet Union.

1993-1994: Working for the Commonwealth of the Northern Mariana Islands, Dr. Hartman developed and presented testimony rebutting a complaint by the United States Department of Justice that the Public School System of the Commonwealth practiced employment discrimination against teachers of Filipino and native Carolinian origin. Dr. Hartman's testimony examined both hiring and compensation practices. His testimony included hedonic regression analysis of the market for public school teachers in the islands. This analysis measured how teacher attributes and qualifications determined teacher salaries and hiring. The results of the analysis indicated that salary differentials resulted from differences in teacher qualifications rather than discrimination.

1993-Present: Working either as the testifying expert or supporting other testifying experts, Dr. Hartman has participated in a variety of patent infringement cases. He has developed, supported and estimated alternative theories and measures of damages for manufacturers of coaxial cable, a variety of alternative medical devices and several generic drug manufacturers.

1993-1998: Working as the testifying expert, Dr. Hartman developed models estimating the damages to the business of a construction general contractor that were caused by the malicious prosecution of the contractor's insurance company.

1994: Working for the United States Wheat Associates in a proceeding before the ITC, Dr. Hartman designed and implemented an econometric study to assess and quantify the extent to which Canadian Wheat Board imports into the U.S. undersold domestic supplies and thereby materially interfered with the United States Department of Agriculture Wheat Program. The econometric study was hedonic. The study measured how non-price attributes are valued in U.S. wheat markets. The non-price attributes analyzed included such things as protein content, shipment defects, moisture content and a number of end-use performance characteristics. Having measured the value of these attributes in U.S. markets, the analysis indicated how the Canadian Wheat Board fixed import prices below market levels, given the attributes of the imported wheat.

1994: Working as a testifying expert for Gallo Wines in a proceeding before the ITC, Dr. Hartman designed and implemented a statistical study of the US wine industry that analyzed the impacts of Chilean wine imports upon the domestic industry that would result from the inclusion of Chile in a Free Trade Agreement with the US.

1994: Working as a testifying expert for an insurer of a member of the Asbestos Claims Facility and Center for Claims Resolution, Dr. Hartman developed a statistical analysis estimating alternative indemnification liabilities expected under the Settlement Share Analysis of the Center for Claims Resolution and under the tort system. The results were used to make strategic decisions regarding the desirability of participating in the Class Action Settlement relative to litigating the claims.

1994: Working for several regional Bell Operating companies, Dr. Hartman has developed models and survey procedures to analyze and quantify the determinants of demand for local services, long-distance

services and PCS services. The models quantify how consumers respond to and select among alternative carriers who differentiate their services by performance attributes and vendor reputation. The models also estimate the level of service demand, conditional upon the selection of service vendor. The models are being used to quantify the nature of competition among local carriers and long-distance carriers in the Intralata market. The models are also being used to help develop bidding strategies for specific RBOCs as they participate in the FCC auctions for the PCS spectra.

1995: Working as a testifying expert for a group of independent television stations and program producers, Dr. Hartman developed an econometric analysis of the impacts of the Prime Time Access Rule (PTAR) upon the economic performance of independent television stations. The analysis was submitted to the Federal Communications Commission as part of their consideration of the repeal of the Rule. Dr. Hartman's analysis proved that PTAR had a strong, statistically significant effect upon the economic performance of these stations, and that its repeal would adversely impact them.

His testimony is included in

The Economic Effects of Repealing the Prime Time Access Rule: Impact on Broadcasting Markets and the Syndicated Program Market, Report prepared by LECG and presented before the Federal Communications Commission, MM Docket No. 94-123, March 7, 1995.

1995: Working for a big six accounting firm, Dr. Hartman designed and implemented a hedonic regression analysis to calculate transfer prices under the comparable uncontrolled price (CUP) method. The analysis is discussed in

"The Use of Regression Techniques in Transfer Price Analysis," with Delores Wright and J.D. Opdyke, *European Taxation*, 1996.

1995-1996: Working as the testifying expert for a major high tech firm in New England, Dr. Hartman has developed rebuttal and affirmative testimony to rebut claims of age discrimination in the termination of a group of employees over forty. His rebuttal testimony involved critically reviewing statistical analyses purporting to demonstrate disparate treatment and disparate impact. His affirmative testimony has involved designing and implementing econometric models to identify and estimate those factors actually determining the compensation and termination decisions of the defendant.

1995-1996: Working as the testifying expert for the Office of Attorney General of the State of Massachusetts, Dr. Hartman has analyzed and helped develop the State's positions on the following issues: restructuring the electric utility industry in Massachusetts and New England; regulating those entities in the restructured industry that will remain subject to regulation; and valuing those assets that may be stranded as a result of restructuring. As part of the effort, Dr. Hartman also critically reviewed the restructuring proposals of the largest utilities in the state. His testimony appears in

"The Market for Power in New England: The Competitive Implications of Restructuring," a report prepared for the Office of the Attorney General, Commonwealth of Massachusetts and submitted February 16, 1996 in support of the filing to the Department of Public Utilities as part of DPU 95-30, which was initiated August 15, 1995.

1995-1996: Working as the testifying expert, Dr. Hartman represented Florida Power Corporation in a contract dispute with Independent Power Producers. His analysis and testimony focused upon issues of damages incurred as a result of a breach of contract.

1995-1999: Working with a team of economists, Dr. Hartman represented the group of wholesalers in the retail prescription drug price fixing conspiracy case. His efforts included industry analysis and participation in cross examination of plaintiffs' experts.

1996: Working as the testifying expert for the Division of Public Utilities of the State of Rhode Island, Dr. Hartman has analyzed and helped develop the State's positions on restructuring the electric utility industry in Rhode Island and New England, for both the State's Public Utilities Commission and the FERC. As part of the effort, Dr. Hartman also critically reviewed the restructuring proposals of some of the utilities in the state. His testimony appears in

"The Division Plan to Restructure the Electric Utility Industry in Rhode Island," Volume 2 of Supporting Testimony to the State of Rhode Island and Providence Plantations Public Utilities Commission, in re: Electric Industry Restructuring, Docket 2320, April 12, 1996.

1996: Working with a team of engineering firms, an international investment banking firm, a big six accounting firm and several national law firms, Dr. Hartman developed models of demand, supply and futures markets in restructured electric power markets to assist a major industry participant in evaluating specific alternative acquisition strategies.

1996: Working with a team of economists developing evidence for presentation before the High Court of New Zealand, Dr. Hartman critically reviewed and rebutted a variety of econometric analyses of natural gas markets and more broadly-defined energy markets in New Zealand. These analyses were used to determine the size of antitrust markets for a variety of energy products.

1996: Dr. Hartman was retained by a major mid-west utility to critically review and rebut analyses and evidence presented before the FERC and the relevant State Commissions concerning the competitive impacts of the proposed Primergy merger.

1996-2003: Working as the testifying expert, Dr. Hartman analyzed the employment practices and procedures of the Florida Power Corporation during a reduction in force, to assess the validity of a complaint that those practices and procedures resulted in a pattern of age discrimination. In his testimony, Dr. Hartman implemented a variety of statistical and econometric analyses to address and quantify claims of disparate impact and disparate treatment.

1996-1997: Working for US Airways with a team of economists, Dr. Hartman specified and estimated a variety of econometric consumer choice models to measure customer preferences for the services of alternative air carriers in a cross section of US-European origin-destination markets. The models were used to evaluate the economic impacts of both the proposed alliance between American Airlines and British Airways and alternative proposals to condition that alliance.

1996-1997: Working as the testifying expert, Dr. Hartman represented a major national retail pharmaceuticals wholesaler in litigation brought by a regional distributor alleging monopolization of wholesale services to distinct classes of trade. His analysis addressed market definition, the analysis of competition generally and analysis of the competitive impact of specific contractual arrangements.

1997: Working with a team of experts, Dr. Hartman analyzed economic impacts of the construction of the Warrior Run Cogeneration plant which was under construction in Western Maryland and was contracted to sell power to Allegheny Power System's (APS) Maryland subsidiary, Potomac Edison.

1997: Working as the testifying expert for the Office of Ratepayer Advocates of the California Public Utilities Commission, Dr. Hartman critically reviewed the efficiencies estimated by Applicants to be induced by the proposed merger of Pacific Enterprises and Enova Corporation.

1997: Working with a team of economists, Dr. Hartman prepared affirmative and rebuttal testimony in a breach of contract matter in the pharmaceutical industry arbitrated before the International Chamber of Commerce.

1997-2000: Working as the testifying expert, Dr. Hartman developed analysis supporting certification of class and estimation of damages for the class of purchasers of thermal fax paper in the US over the period 1990-1992 who were damaged as a result of a price fixing conspiracy by major suppliers.

1998: Working as the testifying expert, Dr. Hartman analyzed the employment practices, procedures and personnel data of the Florida Power Corporation, in general and in particular, to assess the validity of a complaint that a specific employee had been subjected to racial discrimination.

1998-1999: Working with a team of economists for the Office of the Attorney General of the State of Massachusetts, Dr. Hartman developed and implemented econometric models to analyze and measure the health care costs arising under the Medicaid program that have been attributable to smoking. The analysis appears in the following documents:

David M. Cutler, Arnold M. Epstein, Richard G. Frank, Raymond S. Hartman, Charles King and Joseph P. Newhouse, *The Impact of Smoking on Medicaid Spending in Massachusetts: 1970-1998 - Report on Methods*, June 15, 1998;

David M. Cutler, *et. al.*, *The Impact of Smoking on Medicaid Spending in Massachusetts: 1970-1998 - Results From The Inclusive Approach for Adults*, July 1, 1998;

David M. Cutler, *et. al.*, *The Impact of Smoking on Medicaid Spending in Massachusetts: 1991-1998 - Results From The Disease-Specific Approach for Adults and Overall Summary*, July 11, 1998.

Drawing upon these efforts, Dr. Hartman worked with the same team of experts to analyze the economic impacts of the Master Settlement Agreement and to present their findings to the Tobacco Fee Arbitration Panel.

1999: Working as one of two testifying experts for the Office of the Attorney General of the Commonwealth of Massachusetts, Dr. Hartman critically analyzed potential rate increases relevant to Joint Petitions introduced by both Eastern Enterprises/Colonial Gas Company and Boston Edison/Commonwealth Energy Systems. His testimony appears as

Joint Testimony of Seabron Adamson and Raymond Hartman on Behalf of the Massachusetts Attorney General, in the matter of the Joint Petition of Eastern Enterprises and Colonial Gas Company For Approvals of Merger Pursuant to G.L. c. 164, §§ 96 and 94, DTE 98-128, March 26, 1999.

Joint Testimony of Seabron Adamson and Raymond Hartman on Behalf of the Massachusetts Attorney General, in the matter of the Joint Petition of Boston Edison Company, Cambridge Electric Light Company, Commonwealth Electric Company and Commonwealth Gas Company For Approval of Rate Plan Pursuant to G.L. c. 164, §§ 76 and 94, DTE 99-19, April 30, 1999.

1999-2000: Dr. Hartman was retained by a group of industrial purchasers of copper to develop and implement methods and models to assess liability and measure damages in the matter involving the manipulation of the spot and future prices of copper on the London Metals Exchange by Sumitomo Corporation and Yasuo Hamanaka over the period 1987-1996.

1999-Present: Dr. Hartman consulted with counsel and the testifying expert in the development of data and models needed to certify class and measure damages in a price fixing case involving the manufacturer (Mylan) of generic clorazepate and lorazepam.

1999-2001: Working as the testifying expert, Dr. Hartman analyzed liability arising from a variety of restrictive dealer arrangements implemented by Dentsply International Inc., a U.S. manufacturer of artificial teeth, to foreclose entry by rival manufacturers from the US dental-laboratory dealer network. Dr. Hartman developed and implemented methods to measure damages to the class of dental laboratories that purchased artificial teeth from Dentsply at prices above the competitive prices that would have obtained absent the restrictive dealer arrangements.

1999-2000: Working with a team of economists for the Federal Trade Commission, Dr. Hartman analyzed the pro-competitive and anti-competitive nature of settlement agreements between generic and pioneer drug manufacturers resolving patent infringement litigation arising from certification under Paragraph IV of the Hatch Waxman Act (Drug Price Competition and Patent Term Restoration Act). Particular settlements analyzed include the settlement between Abbott Laboratories and Geneva Pharmaceuticals regarding the drug Hytrin and the settlement between Hoechst Marion Roussel (Aventis) and Andrx Corporation regarding the drug Cardizem.

1999-2000: Working as the testifying expert for the class of purchasers of Nine West shoes, Dr. Hartman was asked to analyze liability and measure damages arising from an alleged conspiracy to raise and maintain the prices of women's shoes manufactured by the Nine West Group Inc. and sold by a variety of general merchandise retailers through their upscale retail department stores. The defendants in the case included Nine West Group Inc., Federated Department Stores, Inc., Dayton Hudson Corporation, Lord and Taylor, Nordstrom, Inc., May Department Stores, Macy's, Bloomingdale's, Inc., and other general merchandise retailers.

2000: Working with the testifying expert, Dr. Hartman assisted in the analysis and estimation of economic damages to a Class defined as all smokers with 20-pack years each of whom contracted lung cancer which was substantially contributed to by cigarette smoking.

2000: Working with a team of economists, Dr. Hartman developed econometric models to analyze and measure the impacts of subject imports, non-subject imports and factor price changes upon the prices of structural steel beams during the period 1998-1999. The work was presented before the International Trade Commission.

2001: Working with a team of economists, Dr. Hartman developed econometric models to analyze and measure the impacts of subject imports, non-subject imports and factor price changes upon the prices of structural steel beams and during 2000. He also developed econometric models to analyze and measure the impacts of subject imports, non-subject imports and factor price changes upon the prices of cold rolled and hot rolled steel during the Period of Inquiry of 1997-1999. Both efforts were presented before the International Trade Commission.

2001-2004: Working as the testifying expert, Dr. Hartman developed and submitted testimony in support

of class certification of and the calculation of damages to the class of indirect purchasers of the anti-hypertensive drug, Hytrin, produced by Abbott Laboratories and the generic equivalent of Hytrin, generic terazosin hydrochloride, produced by Geneva Pharmaceuticals. The class alleges monopolization and violation of the Hatch Waxman Act (Drug Price Competition and Patent Term Restoration Act).

2001-Present: Working as consultant and testifying expert, Dr. Hartman has been retained by counsel to the classes of indirect or direct purchasers of a variety of branded pharmaceuticals (including but not limited to Augmentin, Bextra, Cipro (New York, California, U.S.), BuSpar, Celebrex, Vioxx, K-Dur, Taxol, Lupron, Relafen, Paxil, Neurontin, Remeron, Ditropan, Tamoxifen, Premarin, Wellbutrin and Zyprexa) to analyze and submit testimony dealing with class certification, liability, market definition, damage calculations and settlement allocations arising from violations of the Hatch Waxman Act (Drug Price Competition and Patent Term Restoration Act), related state-specific unfair competition statutes and the RICO Act.

Dr. Hartman's testimony in this area has been relied upon (and cited thereto) for certification of defendant-consumer classes in the following matters:

- *In re: Terazosin Hydrochloride Antitrust Litigation*, United States District Court, Southern District of Florida, Case No. 99-MDL-1317-Seitz/Klein [Order Granting Indirect Purchaser Plaintiffs' Motions for Class Certification of State-Wide Classes, April 8, 2004]
- *In re Cipro Cases I and II*, D043543 (JCCP Nos. 4154, 4220), Court of Appeal, Fourth Appellate District, Division One, State of California Decision affirming class certification not titled but marked as "Not to Be Published in Official Reports," Filed 7/21/04]
- *In re: Relafen Antitrust Litigation*, United States District Court, District of Massachusetts, Master File No. 01-12239-WGY [Memorandum granting certification for an exemplar class, May 12, 2004]
- *In re Pharmaceutical Industry Average Wholesale Price Litigation*, United States District Court for the District of Massachusetts, MDL, No. 1456, Civil Action: 01-CV-12257-PBS.
- *New England Carpenters Health Benefits Fund; Pirelli Armstrong Retiree Medical Benefits Trust; Teamsters Health & Welfare Fund of Philadelphia and Vicinity; and Philadelphia Federation of Teachers Health and Welfare Fund, District Council 37, AFSCME - Health & Security Plan; June Swan; Maureen Cowie And Bernard Gorter v. First Databank, Inc., and McKesson Corporation*, United States District Court District of Massachusetts, C.A. No. 1:05-CV-11148-PBS.

Dr. Hartman's testimony has been relied upon (and cited as necessary) for approval of proposed settlement allocations in the following matters:

- *In re: Lupron® Marketing and Sales Practices Litigation*, United States District Court, District of Massachusetts, MDL No. 1430, Master File No. 01-CV-10861-RGS [Memorandum and Order Approving Settlement and Certifying the Class, May 12, 2005]
- *HIP Health Plan of Florida, Inc., On Behalf of Itself and All Others Similarly Situated v. Bristol-Myers Squibb Co. and American Bioscience*, Case Number 1:01CV01295, United States District Court for the District of Columbia
- *In re Buspirone Antitrust Litigation*, MDL No. 1413, United States District Court for

the Southern District of New York

- *In re Relafen Antitrust Litigation*, United States District Court, District of Massachusetts, Master File No. 01-CV-12222-WGY
- *In re Remeron Antitrust Litigation*, United States District Court, District of New Jersey, Master Docket No. 02-CV-2007

2001: Working as consultant to counsel for various U.S. steel producers, Dr. Hartman worked with a team of economists to develop econometric models to analyze and measure the impacts of imports, demand and factor price changes upon the prices of domestically produced carbon steel flat products and carbon steel long products in the Section 201 hearings before the International Trade Commission. Dr. Hartman testified before the ITC in the hearings. The Commission decided in favor of most of the products subject to these analyses.

2001: Working as consultant to counsel for Nucor Steel Corporation, Dr. Hartman worked with a team of economists to develop econometric models to analyze and measure the impacts of imports, demand and factor price changes upon the prices of domestically produced carbon steel cold rolled products for preliminary hearings before the International Trade Commission.

2001-2002: Consulting to counsel for the Plaintiff Class, Dr. Hartman analyzed the targeting of youth by cigarette advertisements in the matter *in re Devin Daniels, et. al., v. Philip Morris Companies, Inc., et. al.*, Case Number 719446, coordinated with JCCP 4042.

2001-2003: Working as testifying expert, Dr. Hartman developed and presented statistical evidence analyzing the relative performance of a particular cardiovascular surgeon litigating the fact that his surgical privileges had been revoked as a result of incompetent surgical performance and results. He testified before an arbitration panel in the matter.

2003: Working as the testifying expert for Defendants, Dr. Hartman submitted testimony analyzing the allegation of racial discrimination on the part of Wells Fargo Home Mortgage, Inc. and Norwest Mortgage, Inc.

2003: Working as a consulting expert to counsel for the class of purchasers of graphite electrodes, Dr. Hartman developed econometric models to assess the impact of alleged antitrust violations.

2003: Working as a consulting expert for counsel to the class of direct purchasers, Dr. Hartman reviewed materials in a matter regarding antitrust allegations concerning the manufacture and sale of microcrystalline cellulose in the United States.

2003: Working as a consulting expert to counsel for a large electrical generation company, Dr. Hartman developed economic and econometric models to analyze the allegation that this electrical generation company participated in a conspiracy to manipulate prices of power sold in California.

2003: Working as the testifying expert, Dr. Hartman submitted testimony which analyzed and calculated the economic impacts and damages to the U.S. growers and quota holders of flue-cured and burley tobacco leaf caused by a price-fixing conspiracy among the major U.S. tobacco leaf buyers and cigarette manufacturers. The \$1.4 billion settlement ultimately reached in the matter was the second highest antitrust settlement in history.

2004: Working as the consulting expert for the United States Department of Justice, Dr. Hartman critically analyzed the calculation of the economic damages borne by an electric power generation utility as a result of the breach of the Standard Contract with the U.S. Department of Energy to remove spent nuclear fuel in 1998. Dr. Hartman's analysis included a critical review and rebuttal of the models and data put forward by the utility's experts in the calculation of damages; the development and presentation of alternative and improved models and corrected data to more accurately calculate damages; a critical review of econometric analyses put forward by one of the utility's experts; and a review of the economics of re-licensing existing nuclear generating facilities.

2004: Working as the testifying expert, Dr. Hartman submitted testimony in support of the certification of the class of purchasers of electrical carbon products who have been alleged to have been impacted and injured economically as a result of a price-fixing customer-allocation conspiracy of the major suppliers of such products in the United States.

2004-Present: Working as the testifying expert, Dr. Hartman submitted testimony in deposition and at trial in support of the certification of the class of end payer purchasers of those pharmaceutical products produced by AstraZeneca, the Bristol Myers Squibb Group, the Johnson and Johnson Group, the Glaxo-Smith-Kline Group and the Schering Plough Group that were subject to an alleged scheme to fraudulently inflate their Average Wholesale Price (AWP), thereby fraudulently inflating the reimbursement rates paid by the Class members for those pharmaceuticals when their reimbursement rates were formulaically related to the AWP. Dr. Hartman developed, implemented and presented at trial a theory of causation and under that theory calculated damages to the relevant indirect purchaser classes. The District Court and Appellate Court found in favor of Plaintiffs. Dr. Hartman has consulted and continues to consult and/or submit testimony on appeals and on related litigation undertaken by the Offices of the Attorneys General for the Medicaid Agencies of the states of New York, Connecticut, Arizona, Nevada, Montana, Texas, Pennsylvania and the Commonwealth of Massachusetts.

2004-2005: Working as a consulting expert to counsel for a major electricity and gas utility holding company, Dr. Hartman developed models to evaluate allegations of affiliate abuse by the regulated gas distribution entities and the trading entities of the holding company. The alleged abuses concerned spot and forward gas markets in California.

2005: Working as the testifying expert for the United States Department of Justice, Dr. Hartman developed models to critically analyze the cost submissions to the U.S. Court of Federal Claims by the TVA for monetary damages alleged to have resulted from partial breach by the U.S. Department of Energy of the Standard Contract to remove spent nuclear fuel from TVA beginning in 2002. Dr. Hartman's analysis included a critical review and rebuttal of the models, data and cost analyses put forward by the utility and the development and implementation of alternative and improved models and corrected data to more accurately calculate costs attributable to the alleged partial breach.

2005-2007: Working again as the testifying expert for the United States Department of Justice, Dr. Hartman developed models to critically analyze the cost submissions to the U.S. Court of Federal Claims by the Systems Fuel Inc., a subsidiary of Entergy, for monetary damages alleged to have resulted from partial breach by the U.S. Department of Energy of the Standard Contract to remove spent nuclear fuel from SFI facilities in Mississippi and Arkansas. Dr. Hartman's analysis has included a critical review and rebuttal of the SFI models, data and cost analyses put forward by the utilities and the development and implementation of alternative and improved models and corrected data to more accurately calculate costs attributable to the alleged partial breach.

2005-2010: Working as one of two testifying experts, Dr. Hartman submitted testimony calculating

monetary damages caused by the allegedly fraudulent promotion of the drug Neurontin for indications that were not approved by the FDA (off-label promotion). As part of his analysis, he consulted on the estimation of the econometric models calculating those prescriptions induced by the off-label promotion. His testimony has been submitted in the MDL and Pennsylvania matters. He has testified at trial in this matter.

2006: Working as the testifying witness for counsel to the named plaintiffs and the class, Dr. Hartman submitted testimony in support of certification of the Indirect Purchasers of the drug Ditropan.

2006-Present: Working as the testifying expert, Dr. Hartman has submitted testimony supporting class certification, liability and calculating damages resulting from an alleged conspiracy between McKesson and First Data Bank to inflate prices paid for a broad spectrum of brand name drugs by manipulating the list prices of those drugs (AWPs and WACs). Once class was certified and damages calculated, Dr. Hartman submitted testimony analyzing and supporting several proposed settlements to the litigation. Dr. Hartman is currently extending his analysis to state AG litigation, to assist those AGs to recover the overcharge damages paid on Medicaid reimbursement as a result of the conspiracy, as well as reimbursement by other governmental agencies.

2007-Present: Working as a consulting expert, Dr. Hartman worked with a team of economists estimating econometric models to analyze and quantify the extent to which allegedly illegal off-label promotion by the manufacturer of the drug Zyprexa caused increases in the amount of Zyprexa prescribed and sold.

2008: Working as the testifying expert, Dr. Hartman submitted testimony supporting certification of and calculation of damages for by the class of users of and payers for the drug Bextra as a result of fraudulent marketing activities and fraudulent clinical representations made by the drug's developers and/or manufacturers (defendants Pharmacia, Pfizer, and Searle).

2008-2009: Working as the testifying expert for the named plaintiffs and the class, Dr. Hartman submitted testimony in support of class certification for the indirect purchasers of the drug Estratest, which was marketed and promoted by its manufacturer Solvay for hormone replacement therapy, despite the fact that it had received no FDA approval to do so even though Solvay had actively sought FDA approval and repeatedly made applications to the FDA for decades.

2008-2009: Working as the testifying expert for the United States Department of Justice, Dr. Hartman developed models to critically analyze the cost submissions to the U.S. Court of Federal Claims by the Energy Northwest. Dr. Hartman's analysis focused upon correct procedures to analyze cost effective responses in the actual world to DOE delays in taking spent nuclear fuel.

2009: Working as the testifying expert for a large health insurer, Dr. Hartman critically assessed whether providers submitted claims in excess of what was allowed under Medicare reimbursement practices and procedures.

2009-2010: Working as one of two testifying experts, Dr. Hartman submitted testimony analyzing liability and calculating monetary damages caused by the allegedly fraudulent promotion of the anti-psychotic drug Risperdal for indications that were not approved by the FDA (off-label promotion). As part of his analysis and testimony, he estimated and presented econometric models calculating those prescriptions induced by the off-label promotion.

2010-Present: Working as a testifying expert, Dr. Hartman developed and submitted testimony in support of class certification, calculation of damages and market definition for the class of indirect purchasers of Provigil.

The class alleges monopolization and violation of the Hatch Waxman Act (Drug Price Competition and Patent Term Restoration Act) to foreclose generic entry.

2010-Present: Working as a testifying expert, Dr. Hartman developed and submitted testimony in support of class certification, calculation of damages and market definition for the class of indirect purchasers of Toprol XL and metoprolol succinate. The class alleges unlawful double patenting and violation of the Hatch Waxman Act (Drug Price Competition and Patent Term Restoration Act) to foreclose generic entry.

Attachment A.2

RAYMOND S. HARTMAN
RECENT APPEARANCES AT DEPOSITION AND TRIAL

2003

In re Terazosin Hydrochloride Antitrust Litigation, Case No. 99-MDL-1317 Seitz/Garber, consolidated, United States District Court for the Southern District of Florida, (deposition)

Anne Cunningham and Norman Mermelstein, Individually and on Behalf of all Others Similarly Situated, v. Bayer AG, Bayer Corporation, Barr Laboratories, Inc, The Rugby Group, Inc., Watson Pharmaceuticals, Inc. and Hoechst Marion Roussel, Inc., Index No. 603820-00, Supreme Court of the State of New York, County of New York (deposition)

In re Ciprofloxacin Hydrochloride Antitrust Litigation, Master File No. 1:00-MD-1383, United States District Court for the Eastern District of New York. (deposition)

Cipro Cases I and II, Judicial Council Coordination Proceeding Nos. 4154 and 4220 (Superior Court, San Diego County) (depositions)

In re Relafen Antitrust Litigation, United States District Court, District of Massachusetts, Master File No. 01-CV-12222-WGY (deposition)

Dr. Gregory Derderian, et. al., Plaintiffs, v Genesys Health Care Systems, et. al., Defendants, Case No. 99-64922-CK, State of Michigan, Circuit Court for the County of Genesee (testimony before arbitration panel)

In re D. Lamar DeLoach, et. al., Plaintiffs, v. Philip Morris Companies, Inc., et. al., Defendants, in the United States District Court for the Middle District of North Carolina, Greensboro Division, Case No. 00-CV-1235 (deposition)

2004

In re Ciprofloxacin Hydrochloride Antitrust Litigation, Master File No. 1:00-MD-1383, United States District Court for the Eastern District of New York (deposition)

In re Lupron Marketing and Sales Practices Litigation, MDL No. 1430, CA No. 01-CV-10861, United States District Court, District of Massachusetts (deposition)

In re Pharmaceutical Industry Average Wholesale Price Litigation, United States District Court for the District of Massachusetts, MDL, No. 1456, CIVIL ACTION: 01-CV-12257-PBS (deposition)

2005

In re Lupron Marketing and Sales Practices Litigation, MDL No. 1430, CA No. 01-CV-10861, United States District Court, District of Massachusetts, (trial)

In re Tennessee Valley Authority, Plaintiff v. United States, Defendant, United States Court of Federal Claims, No. 01-249-C, (deposition, trial)

Lynne A. Carnegie v. Household International, Inc., Household Bank, f.s.b., successor in interest to Beneficial National Bank, Household Tax Masters Inc., formerly known as Beneficial Tax Masters, Inc., Beneficial Franchise Company, Inc., H&R Block, Inc., H&R Block Services, Inc., H&R Block Tax Services, Inc., H&R Block Eastern Tax Services, Inc., Block Financial Corp. and HRB Royalty, Inc., No. 98 C 2178, United States District Court for the Northern District of Illinois Eastern Division, (deposition)

2006

In re Pharmaceutical Industry Average Wholesale Price Litigation, United States District Court for the District of Massachusetts, MDL, No. 1456, Civil Action: 01-CV-12257-PBS (deposition; deposition in related matters for the State of Montana and the State of Nevada; trial)

State of Connecticut v. Dey, Inc., Roxanne Laboratories, Inc., Warrick Pharmaceuticals Corp., Schering-Plough Corp. and Schering Corporation; State of Connecticut v. Pharmacia Corp., and State of Connecticut v. Glaxo Smithkline et al., Superior Court, Complex Litigation Docket at Tolland, Docket Nos. X07 CV-03-0083297-S, X07 CV-03-0083298-S, X07 CV-03-0083299-S (deposition)

System Fuels, Inc., on its own behalf and as agent for System Energy Resources, Inc. and South Mississippi Electric Power Association, Plaintiff, v. The United States, Defendant, in the United States Court of Federal Claims, No. 03-2624C (deposition)

New England Carpenters Health Benefits Fund; Pirelli Armstrong Retiree Medical Benefits Trust; Teamsters Health & Welfare Fund of Philadelphia and Vicinity; and Philadelphia Federation of Teachers Health and Welfare Fund v. First Databank, Inc., and McKesson Corporation, United States District Court District of Massachusetts, C.A. No. 1:05-CV-11148-PBS (deposition)

In re Express Scripts, Inc., PBM Litigation, United States District Court Eastern District of Missouri Eastern Division, Master Case No. 4:05-md-01672-SNL (deposition)

In re Prempro Products Liability Litigation, in the United States District Court for the Eastern District of Arkansas, Western Division, MDL Docket # 4:03CV1507WRW; *In re Hormone Therapy Litigation*, in the Court of Common Pleas Philadelphia County, November 2003, #00001 (deposition)

In re: Neurontin Marketing and Sales Practices Litigation, MDL Docket No. 1629, Master File No. 04-10981, United States District Court, District of Massachusetts (deposition)

System Fuels, Inc., on its own behalf and as agent for Entergy Arkansas Inc., Plaintiff, v. The United States, Defendant, in the United States Court of Federal Claims, No. 2623C (deposition)

2007

System Fuels, Inc., on its own behalf and as agent for System Energy Resources, Inc. and South Mississippi Electric Power Association, Plaintiff, v. The United States, Defendant, in the United States Court of Federal Claims, No. 03-2624C (trial)

New England Carpenters Health Benefits Fund; Pirelli Armstrong Retiree Medical Benefits Trust; Teamsters Health & Welfare Fund of Philadelphia and Vicinity; and Philadelphia Federation of Teachers Health and Welfare Fund v. First Databank, Inc., and McKesson Corporation, United States District Court District of Massachusetts, C.A. No. 1:05-CV-11148-PBS (video taped tutorial)

2008

Energy Northwest v. The United States, United States Court of Federal Claims, No. 04-10C (deposition)

The Commonwealth of Massachusetts v. Mylan Laboratories, et al., United States District Court for the District of Massachusetts, Civil Action No. 03-CV-11865-PBS (deposition)

Susannah K. Alexander, Individually and on Behalf of all Others Similarly Situated, Plaintiffs, v. Solvay Pharmaceuticals, Inc., et al., Defendants, Superior Court of the State of California, County of Los Angeles, Case Number BC300364 (deposition)

Gregory Clark and Linda Meashey, individually and on behalf of others similarly situated v. Pfizer Inc., and Warner-Lambert Company, LLC, No. 01819, Philadelphia County Court of Common Pleas (deposition)

2009

Energy Northwest v. The United States, United States Court of Federal Claims, No. 04-10C (trial)

In re: Neurontin Marketing and Sales Practices Litigation, MDL Docket No. 1629, Master File No. 04-10981, United States District Court, District of Massachusetts (deposition)

The State of Texas ex. rel. & Ven-a-Care of the Florida Keys, Inc., Plaintiffs, v. Sandoz Inc., et.al., Mylan Pharmaceuticals Inc., et.al., and Teva Pharmaceuticals U.S.A. Inc., et.al., Defendants, Cause No. D-1 - GV-07-001259, in the District Court of Travis County, Texas, 201st Judicial District (deposition)

In re Charles Foti, Attorney General ex rel, State of Louisiana v. Janssen Pharmaceutica, Inc., et al., 27th Judicial District Court, Parish of St. Landry, Docket No. 04-C-3967-D (deposition)

2010

In re: Neurontin Marketing, Sales Practice, and Products Liability Litigation, The Guardian Life Insurance Company of America v. Pfizer Inc., MDL Docket No. 1629, Master File No. 04-10981, 04 CV 10739 (PBS), United States District Court for the District of Massachusetts (trial)

In re: SmithKline Beecham Corporation, SmithKline Beecham, p.l.c., and Beecham Group, p.l.c., v. Apotex Corporation, Apotex Inc. and TorPharm, Inc., v. SmithKline Beecham Corporation, SmithKline Beecham, p.l.c., Beecham Group, p.l.c., Pentech Pharmaceuticals, Inc. and Par Pharmaceuticals, Inc., United States District Court for the Eastern District of Pennsylvania, CA No. 00-CV-4304 (deposition)

In re: The State of Texas ex. rel. Ven-a-Care of the Florida Keys, Inc., Plaintiffs, v. Alpharma USPD f/k/a Barre-National, Inc., et al., Cause No. D-1-GV-08-001566, in the District Court of Travis County, Texas, 419th Judicial District (2 depositions)

In re: McKesson Governmental Entities Average Wholesale Price Litigation, United States District Court for the District of Massachusetts, Case No. 1:08-CV-10843-PBS (deposition)

The Commonwealth of Massachusetts v. Mylan Laboratories, et al., United States District Court for the District of Massachusetts, Civil Action No. 03-CV -11865-PBS (evidentiary hearing (July) and trial (September))

2011

The State of Texas ex. rel. & Ven-a-Care of the Florida Keys, Inc., Plaintiffs, v. Alharma USPD f/k/a Barre-National, Inc., et. al., Cause No. D-1-GV-08-001566, in the District Court of Travis County, Texas, 419th Judicial District (trial).

United States of America ex rel. Kassie Westmoreland v. Amgen Inc., United States District Court for the District of Massachusetts, Civil Action No. 06-10972-WGY (deposition)

In Re: Metoprolol Succinate End-Payor Antitrust Litigation, United States District Court for the District of Delaware, CA No. 06-71 GMS (deposition).

Vista HealthPlan Inc., et. al., Plaintiffs v. Cephalon, Inc., et. al., Defendants, In the United States District Court for the Eastern District of Pennsylvania, CA No. 06-CV-01833 (deposition).

2012

Toyota Motor Corp. Unintended Acceleration Marketing, Sales Practices, and Products Liability Litigation, Case No. 8:10-ml-02151-JVS (C.D. Cal) (deposition).