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Environmental  
Protection Agency

EPA Science Advisory  
Board (1400F)  
Washington DC

EPA-SAB-ADV-05-XXX  
June 2005  
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# IDENTIFYING AND CALCULATING ECONOMIC BENEFIT THAT GOES BEYOND AVOIDED AND/OR DELAYED COSTS: AN SAB ADVISORY

**AN ADVISORY OF THE ILLEGAL  
COMPETITIVE ADVANTAGE (ICA)  
ECONOMIC BENEFIT (EB) ADVISORY  
PANEL OF THE EPA SCIENCE  
ADVISORY BOARD**

**June 15, 2005**

**DELIBERATIVE DRAFT  
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1 UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
2 WASHINGTON D.C. 20460

3  
4 OFFICE OF  
5 THE ADMINISTRATOR  
EPA SCIENCE ADVISORY BOARD

6 June 15, 2005

7 Note to the Reader:

8 The attached deliberative draft advisory "*Identifying and Calculating Economic Benefit*  
9 *That Goes Beyond Avoided and/or Delayed Costs: An SAB Advisory*," is undergoing deliberations  
10 for SAB Quality Review. Draft documents at this stage of the process often undergo significant  
11 revisions.

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1 June 15, 2005

2 EPA-SAB-ADV-05-XXX

3 The Honorable Stephen L. Johnson  
4 Administrator  
5 U.S. Environmental Protection Agency  
6 1200 Pennsylvania Avenue, NW  
7 Washington, DC 20460

8 Subject: An Advisory of the Illegal Competitive Advantage (ICA) Economic  
9 benefit (EB) Advisory Panel of the EPA Science Advisory Board

10 Dear Administrator Johnson:

11 The EPA Science Illegal Competitive Advantage (ICA) Economic Benefit Advisory  
12 Panel of the Science Advisory Board has completed its review of Agency's Office of  
13 Enforcement and Compliance Assurance (OECA) White Paper entitled "*Identifying and*  
14 *Calculating Economic Benefit That Goes Beyond Avoided and/or Delayed Costs*," dated May  
15 25, 2003. The Panel conducted its review in a public teleconference call on July 12 and a  
16 meeting August 5 & 6, 2004, followed by three public conference calls on September 22,  
17 November 4, 2004 and January 19, 2005. The results of the Panel's efforts were  
18 administratively reviewed and approved by the Board.

19 The EPA has made the violator's economic benefit from violating the law the centerpiece  
20 of its calculation of civil penalties. The economic benefit from noncompliance consists of three  
21 possible components: (A) the economic benefit from *delayed costs* associated with  
22 noncompliance; (B) the economic benefit from *avoided costs* associated with noncompliance;  
23 and (C) the economic benefit from an *illegal competitive advantage* generated by  
24 noncompliance. The Agency identifies four categories of cases in which the economic gain of  
25 noncompliance with an environmental regulation will go beyond the benefit of delaying or  
26 avoiding compliance costs. It refers to these as "Illegal Competitive Advantage" (ICA). The  
27 four categories of cases are:

- 28 - violator gains additional market share;
- 29 - violator sells products or services prohibited by law;
- 30 - violator initiates construction or operation prior to government approval; and

1 - violator operates at higher capacity than it should have.  
2

3 The Agency has asked our advice regarding these categories and the proposed methods for  
4 estimating economic benefit for each.

5 The fundamental question for the determination of a penalty based on economic benefit is  
6 how much did the profits of the firm increase as a result of its noncompliance? Profits can be  
7 increased either by an increase in revenue or a decrease in the total cost of production (including  
8 abatement costs), or some combination of both. The Agency's White Paper has essentially  
9 placed all of the factors influencing revenues in one of the four categories under the heading of  
10 "benefit from illegal competitive advantage."

11 The Panel finds the Agency's use of the term "illegal competitive advantage" to be  
12 unhelpful. It would be more transparent to have only two categories: (i) when economic  
13 advantage is limited to delayed or avoided compliance costs; and (ii) when economic advantage  
14 includes profits on increased sales. For all of those cases in which revenues increase, we  
15 recommend that the Agency examine the facts of each case and use methods and data  
16 appropriate to the case to estimate the changes in streams of revenue and/or production costs as  
17 well as delayed or avoided compliance costs (if any). We suggest an approach to revising the  
18 White Paper that is consistent with our recommendations.

19 The Panel also considered some broader issues relating to the determination of the  
20 magnitude of penalties for noncompliance. We believe that one of these is of particular  
21 importance to the Agency. This is the economic theory of optimal penalties. This theory makes  
22 two points that are relevant to EPA's penalty policy. The first is based on the assumption that  
23 potential offenders respond to both the probability of detection and the severity of punishment if  
24 detected and punished. Thus, deterrence may be enhanced by raising the penalty, by increasing  
25 monitoring activities to raise the likelihood that the offender will be caught, or by changing legal  
26 rules to increase the probability of punishment. And second, the economically optimal penalty  
27 balances the harm done by an offense against the cost of deterring the offense in one or another  
28 of these ways. This balancing leads to the conclusion that in those cases where the objective of  
29 regulation is to achieve economic efficiency the appropriate methodology for calculating a  
30 penalty is to charge an amount per offense equal to the (monetized) harm done divided by the  
31 probability of punishment.

32 The Panel believes that the state-of-the-art in benefits estimation has progressed to the

1 point where EPA should seriously explore how it might incorporate “harm-based” measures into  
2 its penalty formula, at least for some types of environmental harm. We also recommend that the  
3 Agency explore ways to incorporate more explicitly the probability of detection and punishment  
4 into its penalty policy as a way of enhancing the deterrent effects of its penalties.

5 Finally, if our recommendations regarding the penalty policy and the revisions to the  
6 White Paper are accepted, it will be necessary for the Agency to provide economic input into  
7 these processes. The necessary economic expertise could come either from the National Center  
8 for Environmental Economics or by adding an economist to the staff of the OECA.

9 We are pleased to have participated in this process and are particularly interested in your  
10 response to the points we raise in this report.

11

12

Sincerely,

13

14

15 Dr. M. Granger Morgan, Chair  
16 EPA Science Advisory Board

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Dr. A. Myrick Freeman III, Chair  
Illegal Competitive Advantage (ICA) Economic  
Benefit (EB) Advisory Panel  
EPA Science Advisory Board

**NOTICE**

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This report has been written as part of the activities of the EPA Science Advisory Board, a public advisory committee providing extramural scientific information and advice to the Administrator and other officials of the Environmental Protection Agency. The Board is structured to provide balanced, expert assessment of scientific matters related to problems facing the Agency. This report has not been reviewed for approval by the Agency and, hence, the contents of this report do not necessarily represent the views and policies of the Environmental Protection Agency, nor of other agencies in the Executive Branch of the Federal government, nor does mention of trade names or commercial products constitute a recommendation for use. Reports of the EPA Science Advisory Board are posted on the EPA website at <http://www.epa.gov/sab>.

1 **ABSTRACT**

2 The U.S. Environmental Protection Agency’s Illegal Competitive Advantage (ICA)  
3 Economic Benefit (EB) Advisory Panel (“the Panel”) provided advice on four charge questions  
4 relating to an Agency White Paper entitled “*Identifying and Calculating Economic Benefit That*  
5 *Goes Beyond Avoided and/or Delayed Costs*,” dated May 25, 2003.

6 The EPA has made the recovery of a violator’s economic benefit from violating the law  
7 the basis of its calculation of civil penalties. The Agency has asked the Panel for advice in  
8 estimating economic benefits when a firm’s noncompliance enables it to increase sales (which  
9 EPA terms “illegal competitive advantage” or ICA) , as opposed to simply avoiding or delaying  
10 compliance costs. The Panel suggests that the four categories of cases identified by EPA as  
11 falling under the term ICA and described in the White Paper are not helpful for several reasons.

12 The Panel suggests that in all those cases in which revenues increase, the Agency should  
13 examine the facts of each case and use methods and data appropriate to the case to estimate the  
14 changes in streams of revenue and production costs, as well as any delayed or avoided  
15 compliance costs.

16 After a review of the economic theory of optimal penalties, the Panel recommends that  
17 the Agency explore ways to explicitly incorporate the probability of detection and punishment  
18 into its penalty policy. The Panel also believes that the state-of-the-art in benefits estimation has  
19 progressed to the point where EPA should seriously explore how it might incorporate “harm-  
20 based” measures into its penalty formula, at least for some types of harm.

21 **Key Words:** Compliance, Economic Benefit, Economic Gain, Enforcement, Harm-Based  
22 Measures, Illegal Competitive Advantage, Optimal Penalties

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2 **Science Advisory Board**  
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**U.S. Environmental Protection Agency  
Science Advisory Board**

- - - SAB Roster to be Inserted - - -

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## 1. EXECUTIVE SUMMARY

The Illegal Competitive Advantage (ICA) Economic Benefit (EB) Advisory Panel of the EPA Science Advisory Board (SAB) reviewed and evaluated a White Paper entitled “*Identifying and Calculating Economic Benefit That Goes Beyond Avoided and/or Delayed Costs*,” dated May 25, 2003, as well as supplemental materials, along with a charge for the Panel. The Panel held a conference call on July 12, 2004, met in Washington, DC, on August 5-6, 2004, and conducted follow-up conference calls on September 22, November 4, 2004, and January 19, 2005 to conclude its activity.

### 1.1 Current Civil Penalty Policy at the Agency

Since 1978, the EPA has made the violator’s economic benefit from the violating the Clean Air and Clean Water Acts the centerpiece of its calculation of civil penalties. In the Agency’s view, the economic benefit from noncompliance consists of three possible components: (A) the economic benefit from *delayed costs* associated with noncompliance; (B) the economic benefit from *avoided costs* associated with noncompliance; and (C) the economic benefit from an *illegal competitive advantage* generated by noncompliance. The EPA’s request to the SAB deals with one aspect of just one of these three components of a penalty, the assessment of illegal competitive advantage in the calculation of economic benefit.

The EPA *Policy on Civil Penalties* establishes “a single set of goals for penalty assessment in EPA administrative and judicial enforcement actions.” These goals are characterized as “deterrence, fair and equitable treatment of the regulated community, and swift resolution of environmental problems (U. S. EPA, 1984a, p. 1).” We focus on the first two items – *fairness* and *deterrence* – as primary objectives in the determination of a civil penalty.

The deterrence objective is clearly recognized in the EPA’s penalty process. But one consideration that plays a substantial role in the economic theory of deterrence appears to be entirely missing from the current penalty assessment process; this is the probability of detection and punishment associated with the violation in question.

1 An important aspect of fairness is the *restoration of the status quo*: the law has been  
2 violated, and one objective of the penalty system is to return the status quo before the violation  
3 occurred. Requiring the polluter to surrender the profit he gained by not complying with the law  
4 is one important aspect of restoration of the status quo. However, removing the economic  
5 benefit is not the *only* action that might be required in order to restore the status quo. With a  
6 violation of an environmental regulation, there is a loss resulting from the polluter's action in the  
7 form of some harm to the natural environment. Whether the natural resource that is harmed  
8 belongs to a private individual or the general public, restoration of the status quo can call for  
9 some appropriate compensatory action, perhaps in the form of a penalty based on harm to the  
10 environment rather than on gain to the polluter.

11 These two points raise issues that lie outside of the charge to the Panel. Nevertheless the  
12 Panel believes that they deserve consideration in the continuing evolution of the Agency's civil  
13 penalty policy. Further discussion is deferred to the concluding section of this report.

14 Regarding the calculation of economic gain, the Agency developed the BEN model to  
15 estimate the economic benefits that result from cost-savings during the time that a facility is not  
16 in compliance. Because BEN is presently limited to calculating the difference in discounted  
17 cash flows that result from cost-savings during noncompliance, it is not now configured to  
18 support recapture of benefits that could result from higher revenues. There is, however, no  
19 inherent reason that BEN could not be modified so that it could be used to estimate the benefits  
20 of higher revenues.

21 In its White Paper the Agency identifies four categories of cases in which the economic  
22 gain of noncompliance with an environmental regulation will go beyond the benefit of delaying  
23 or avoiding compliance costs. It refers to these as instances of "Illegal Competitive Advantage"  
24 (ICA). The four categories of cases are:

- 25 - violator gains additional market share;
- 26 - violator sells products or services prohibited by law;
- 27 - violator initiates construction or operation prior to government approval; and
- 28 - violator operates at higher capacity than it should have.

29

1 The Agency has asked our advice regarding these categories and the proposed methods for  
2 estimating economic benefit for each.

3

## 4 **1.2. The Panel's Responses**

5 The fundamental question for the determination of the economic benefit component of  
6 the penalty is how much the profits of the firm increased as a result of its noncompliance. Profits  
7 can be increased either by an increase in revenue or a decrease in the total cost of production  
8 (including abatement costs), or some combination of both. The BEN model provides a reliable  
9 measure of the change in after-tax profit only if no other change would have occurred that would  
10 have affected the firm's profit. There are several factors other than cost that might influence the  
11 amount by which the violator's profit was increased by the violation. The Agency's White Paper  
12 has essentially placed all of these factors in one of four categories under the heading of "benefit  
13 from illegal competitive advantage."

14 For several reasons, the Panel finds that the Agency's use of the term "illegal competitive  
15 advantage" and its identification of the four categories of ICA cases is unhelpful.

16 1. It is not clear what the modifier "competitive" is intended to convey.

17 2. Increases in market share will often be difficult to identify in terms of comparing the  
18 noncompliance scenario with the counterfactual compliance scenario; and observed increases in  
19 market share might be difficult to attribute exclusively to the noncompliance.

20 3. In any case, increases in market share are not inherently valuable to the firm; what  
21 matters is the impact of changes in market share on profits.

22 4. The other categories of ICA appear to stem from unusual circumstances that are very  
23 context dependent.

24 It would be more transparent to have only two categories: (i) when firms that experienced  
25 no revenue increase so that profits were increased only by the amount of the delayed or avoided  
26 compliance costs; and (ii) when firms gained profits from increased sales. The BEN model, as

1 currently configured, may be used as a calculation tool in the first category of cases. For the  
2 other category, we recommend that the Agency examine the facts of each case and use methods  
3 and data appropriate to the case to estimate the changes in streams of revenue and/or production  
4 costs as well as delayed or avoided compliance costs (if any). BEN may be reconfigured to  
5 assist in the calculation once the facts are known and relevant shifts in supply curves have been  
6 estimated.

7 When non-compliant firms sell more than they would have had they complied, their  
8 economic benefit includes the profits they earn on the increased sales. We use a simple  
9 economic model to identify the economic gain due to noncompliance. We show that when a  
10 firm is able to increase sales, using avoided costs at the actual quantity produced overstates the  
11 true economic benefits of noncompliance.

12 There are two situations in which a calculation of economic benefit based only on  
13 avoided/delayed costs could still be justified. The first is if it can be assumed that the effect on  
14 marginal cost and therefore output is sufficiently small that the error induced by ignoring output  
15 effects is also small. The second is if compliance would affect fixed costs only. In that case,  
16 compliance would leave marginal cost and, accordingly, output unchanged.

17 Before answering the charge questions, we consider each of the four categories of ICA  
18 described in the White Paper in more detail and offer comments on the appropriate methods for  
19 estimating economic benefit for each.

20 Our answers to the four charge questions are as follows:

21 **1. Are there categories of cases that would be useful for the Agency to consider in**  
22 **calculating the ICA economic benefit, other than those that are identified in the White**  
23 **Paper? Should any of these be combined?**

24 We do not think that the categories offered in the White Paper are particularly useful. In  
25 fact we believe that they should be combined into only one category - cases where profits  
26 increase at least in part due to increases in revenue.

1           **2. How can the Agency more accurately characterize the types of cases that are**  
2 **described in the White Paper? Have any of the examples and counter-examples in the**  
3 **White Paper been misidentified with regard to whether they are amenable to the BEN**  
4 **model’s simplifying paradigm?**

5           As indicated above, we do not think that the categorization of cases in the White Paper is  
6 useful. However, the White Paper is correct in its statements about whether specific cases can be  
7 analyzed within the BEN framework as that model is currently configured..

8           **3. Are there any suggestions for modifying the described analytical approach to**  
9 **calculate the economic benefits and;**

10           We believe that there is no substitute for a careful examination of the facts of each case  
11 and the use of methods and data appropriate to each case to estimate the changes in streams of  
12 revenue and/or production costs as well as delayed or avoided compliance costs (if any).

13           **4. The Agency’s proposed approach strives to avoid double-counting of the benefit**  
14 **by laying out all relevant cash flows stemming from the violations, as opposed to simply**  
15 **adding on the additional calculations to a BEN run. What additional measures (if any)**  
16 **should the Agency put in place to avoid such potential double-counting?**

17  
18           Every effort should be made to calculate economic advantage as avoided/delayed costs  
19 (and therefore not to decompose the gain into separate components.) One should only resort to a  
20 full-blown change-in-profit analysis when avoided/delayed costs leads to a clearly substantial  
21 overestimate or underestimate of the economic benefit. If it is necessary to do change-in-profit  
22 analysis, it is important that the estimate of costs under compliance reflect the lower level of  
23 output the firm would have produced rather than the actual production of the polluter.

24           In order for the Office of Enforcement and Compliance Assurance (OECA) to implement  
25 our recommendations, it will need to have access to the relevant expertise in economics. One  
26 possible source of this expertise in the Agency is the National Center for Environmental  
27 Economics (NCEE). But it might be more useful to OECA to have its own in-house economist.  
28 This would be especially true if the agency accepts our recommendations in Section 6.4 for  
29 rethinking the civil penalty policy.



1 **1.3. *Ex Ante vs. Ex Post Assessments***

2 A conceptual issue is whether the economic benefit from noncompliance should be  
3 measured as the benefit the violator expects at the time it decides not to comply or the benefit it  
4 actually realizes. (In economic terminology, the former is referred to as the *ex ante* benefit  
5 whereas the latter is the *ex post* benefit). These can be quite different. Panel members debated  
6 whether and when *ex ante* penalties would be more appropriate than the *ex post* version. Most  
7 members could envision cases in which an *ex ante* penalty would be more desirable, either for  
8 fairness or deterrence reasons, but the panel was unable to formulate general rules that would  
9 arguably cover all possible decision situations for EPA.

10 To the extent that a violator should pay a penalty based on its expected rather than its  
11 realized economic benefit, there remains the practical issue of how that benefit is to be  
12 determined. Without knowing exactly what information is available, it is hard to describe how  
13 to perform an expected benefit calculation that would withstand judicial scrutiny. However, the  
14 Panel believes that cases might arise in which the Agency should consider putting forward an  
15 expected benefit calculation as an alternative measure of harm.

16 **1.4. Toward an Optimal Penalty Policy**

17 The economic theory of optimal penalty approaches the issue of deterrence from the  
18 perspective of economic efficiency rather than that of fairness. This theory makes two points  
19 that are relevant to EPA's penalty policy. The first is based on the assumption that potential  
20 offenders respond to both the probability of detection and the severity of punishment if detected  
21 and punished. Thus, deterrence may be enhanced by raising the penalty, by increasing  
22 monitoring activities to raise the likelihood that the offender will be caught, or by changing legal  
23 rules to increase the probability of punishment. And second, the economically efficient penalty  
24 balances the harm done by an offense against the cost of deterring the offense in one or another  
25 of these ways. This balancing leads to the conclusion that the appropriate methodology for  
26 calculating a penalty is to charge an amount per offense equal to the (monetized) harm done,  
27 divided by the probability of punishment.

1 If an environmental violation results in emissions levels that are beyond a legal standard,  
2 there is likely to be some harm to natural resources or human health. Measuring people’s value  
3 for non-market items in monetary terms (e.g., measuring what they would be willing to pay to  
4 prevent a specific harm to the natural environment) is inherently difficult, and in practice  
5 different measurement techniques can produce different results. We also recognize that while  
6 some of the methods used to value environmental harm can be employed with relatively little  
7 cost, others require significant resources. Thus, in many cases, these methods may not be  
8 practical unless the harm, and thus the expected penalty, is extremely large. Nevertheless, the  
9 Panel believes that the state-of-the-art in benefits estimation has progressed to the point where  
10 EPA should seriously explore how it might incorporate “harm-based” measures into its penalty  
11 formula, at least for some types of environmental harm.

12 The probability of detection is likely to vary considerably by type of violation and even  
13 across jurisdictions. An extremely harmful environmental violation is likely to have a  
14 probability of detection and punishment of nearly one. If so, the optimal penalty for such a  
15 violation is likely to be very close to the monetary equivalent of the harm. However, as the size  
16 of the harm decreases, all else equal, we expect that the likelihood of detection also decreases.  
17 Other factors that might influence the probability of detection and punishment are: (a) whether a  
18 violator is subject to mandatory reporting that is available for the public to use in filing citizen  
19 lawsuits, (b) the ratio of facilities to inspectors in an EPA region, (c) the strength of  
20 environmental activism in a region/state, and (d) whether the violator has a history of violations  
21 and thus has been subject to increased scrutiny or targeted enforcement.

22 Although not widely employed in the environmental literature to date, numerous  
23 techniques are available to estimate the probability of detection and punishment. One widely  
24 used method is the “time until capture” approach which is most appropriate for ongoing  
25 violations that occur over a period of time. Another method - the “capture/recapture” approach  
26 is an adaptation of methods used to estimate the number of animals in a given geographic area.

27 The current EPA Penalty Policy starts with the calculation of “gain” – i.e. estimating the  
28 amount that the offender saved by not complying with environmental regulations, and then adds  
29 a “gravity” component based in part on the harm from the offense. However, the policy does not  
30 provide for quantifying the “harm” in monetary terms and also ignores any explicit consideration  
31 of the probability of detection. In those cases where the goal of regulation is to achieve

1 economic efficiency, the penalty should be based on an estimate of the harm rather than the gain  
2 due to noncompliance. If harm cannot be quantified, the base might either be “gain” or a  
3 “default” fine level that is specified by type of offense. This base fine would then be multiplied  
4 by a factor that is based on an estimate of the probability of detection. It should be emphasized  
5 that what is sought here is an approximate estimate of the general probability of detection, not a  
6 highly elaborate calculation tailored to all the specific details of the particular violation.

1

## 2. INTRODUCTION

2

### 2.1 Request for EPA Science Advisory Board (SAB) Review

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At the request of the EPA Office of Enforcement and Compliance Assurance (OECA), the EPA Science Advisory Board convened a Panel to review and evaluate a White Paper entitled "*Identifying and Calculating Economic Benefit That Goes Beyond Avoided and/or Delayed Costs*," dated May 25, 2003, as well as supplemental materials, along with a charge for the Panel (U.S. EPA, 2003). The White Paper identifies four categories of cases in which the economic gain of noncompliance with an environmental regulation will go beyond the benefit of delaying or avoiding compliance costs, provides examples and counterexamples of each, and briefly describes how the economic gain can be calculated. The four categories of cases are:

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- violator gains additional market share;

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- violator sells products or services prohibited by law;

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- violator initiates construction or operation prior to government approval; and

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- violator operates at higher capacity than it should have.

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The proposed charge to the ICA EB Advisory Panel of the SAB was developed based on discussions between the OECA and SAB Staff offices. The specific charge questions are presented in Section 3.5 below.

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### 3. CURRENT AGENCY PRACTICE AND QUESTIONS FOR THE PANEL

#### 3.1 Statutory Provisions and the EPA Penalty Policy - Recapture Economic Gain

The U.S. Environmental Protection Agency (EPA) exercises primary enforcement responsibility for many of the federal environmental protection laws, including the Clean Air Act (CAA); the Clean Water Act (CWA); the Oil Pollution Act (OPA); the Safe Drinking Water Act (SDWA); the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA); the Toxic Substances Control Act (TSCA); the Resource Conservation and Recovery Act (RCRA); the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); and the Emergency Planning and Community Right-to-Know Act (EPCRA). While each of the statutes is different in its particulars, they generally provide for the assessment of civil penalties in the event of noncompliance, and they offer some guidance as to the factors that should be considered when assessing a civil penalty. For example, Section 7413(e)(1) of the CAA states:

In determining the amount of any penalty to be assessed under this section or section 7604(a) of this title, the Administrator or the court, as appropriate, shall take into consideration (in addition to such other factors as justice may require) the size of the business, the economic impact of the penalty on the business, the violator's full compliance history and good faith efforts to comply, the duration of the violation as established by any credible evidence (including evidence other than the applicable test method), payment by the violator of penalties previously assessed for the same violation, *the economic benefit of noncompliance*, and the seriousness of the violation [emphasis added].

Section 7524(b) of the CAA, dealing with mobile sources, states:

In determining the amount of any civil penalty to be assessed under this subsection, the court shall take into account the gravity of the violation, *the economic benefit or savings (if any) resulting from the violation*, the size of the violator's business, the violator's history of compliance with this title, action taken to remedy the violation, the effect of the penalty on the violator's ability to continue in business, and such other matters as justice may require [emphasis added].

1           Since 1978, the EPA has based civil penalties under the CAA and CWA on the violator’s  
2 economic benefit from violating the law (U.S. EPA “Civil Penalty Policy” 1978). The monetary  
3 estimate of the economic benefit from noncompliance becomes the starting point for establishing  
4 a penalty, and this is then adjusted up or down based on a qualitative assessment of other  
5 considerations such as the factors listed above. This approach was further formalized in  
6 February 1984 when the EPA issued the *Policy on Civil Penalties*, EPA Enforcement Policy  
7 #GM-21 and the accompanying *Framework for Statute-Specific Approaches to Penalty*  
8 *Assessments*, EPA General Enforcement Policy #GM-22. As explained in the latter document:  
9 ”The development of a penalty figure is a two-step process. First the case development team  
10 must calculate a preliminary deterrence figure. This figure is composed of the economic benefit  
11 component (where applicable) and the gravity component. The second step is to adjust the  
12 preliminary deterrence figure through a number of factors (U. S. EPA, 1984b, p. 2).”

13           According to the 1984 Guidelines, the economic benefit from noncompliance consists of  
14 three possible components: (A) the economic benefit from *delayed costs* associated with  
15 noncompliance; (B) the economic benefit from *avoided costs* associated with noncompliance;  
16 and (C) the economic benefit from an *illegal competitive advantage* generated by  
17 noncompliance.

18           Following the assessment of the economic benefit, the EPA then performs an assessment  
19 of the gravity component. This involves ranking different types of violations according to the  
20 seriousness of the act, considering (i) actual or possible harm, (ii) importance to the regulatory  
21 scheme, and (iii) availability of data from other sources. In evaluating the actual or possible  
22 harm, consideration should be given to (a) the amount of pollutant, (b) toxicity of pollutant, (c)  
23 sensitivity of the environment, (d) length of time of a violation, and (e) size of the violator.  
24 Having ranked the violations, according to the 1984 Guidelines one “then should assign  
25 appropriate dollar amounts or ranges of amounts to the different ranked violations to constitute  
26 the ‘gravity component.’ This amount, added to the amount reflecting benefit, constitutes the  
27 preliminary deterrence figure (U. S. EPA, 1984b, p. 3).”

28           In the second step, the preliminary deterrence amount is adjusted “to ensure that penalties  
29 also further Agency goals besides deterrence (i.e. equity and swift correction of environmental

1 problems). ... Adjustments (increases or decreases, as appropriate) that can be made to the  
2 preliminary deterrence penalty to develop an initial penalty target to use at the outset of  
3 negotiation include:

- 4 a. degree of willfulness and/or negligence;
- 5 b. cooperation/noncooperation through pre-settlement action;
- 6 c. history of noncompliance;
- 7 d. ability to pay; and
- 8 e. other unique factors (including strength of case, competing public  
9 policy considerations) ((U. S. EPA, 1984b, pp. 3-4).”

10 In summary, the dollar amount which the EPA calculates as its initial penalty target is  
11 derived by calculating the economic benefit, adding a monetary amount which reflects the  
12 gravity component, and adjusting the resulting total up or down based on the considerations  
13 listed immediately above.

14 The EPA’s request to the SAB deals with one aspect of just one of these three stages in  
15 the development of a penalty target, the assessment of illegal competitive advantage in the  
16 calculation of economic benefit. Nevertheless, before we address this question, it is useful to  
17 situate the penalty procedure in the broader context of the economic and public policy  
18 considerations that bear on the determination of a penalty for noncompliance with environmental  
19 regulations.

### 20 3.2 The Objectives of Penalties

21 The EPA *Policy on Civil Penalties* establishes “a single set of goals for penalty  
22 assessment in EPA administrative and judicial enforcement actions.” These goals are  
23 characterized as “deterrence, fair and equitable treatment of the regulated community, and swift  
24 resolution of environmental problems (U. S. EPA, 1984a, p. 1).” In the context of our present  
25 analysis, we see the last item as being more a *constraint* than an objective: whatever the formula  
26 for assessing a civil penalty, it needs to be practical and amenable to implementation in a  
27 reasonably timely manner. Accordingly we focus on the other two items – *fairness* and  
28 *deterrence* – as primary objectives in the determination of a civil penalty; they are clearly  
29 evident in the statutory provisions quoted above.

1 Deterrence and, especially, fairness have multiple possible interpretations depending on  
2 both the philosophical position one adopts and how one interprets the violation of an  
3 environmental law from a public policy perspective. In this section we note some issues that  
4 arise in conceptualizing the objectives of fairness and deterrence.

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6 An important aspect of fairness is what might be called the *restoration of the status quo*:  
7 the law has been violated and the restorative objective of a penalty system is to undo the  
8 violation and return the situation to how it was before the violation occurred. This is clearly the  
9 major focus of the EPA's civil penalty policy since 1978. The assumption underlying this policy  
10 is that the noncompliance with environmental regulations was associated with, and perhaps  
11 motivated by, some increase in profit to the responsible party (from now on, we will use "the  
12 polluter" as a shorthand term to refer to this party). Whether or not the assumption is correct is  
13 obviously an empirical question that depends on the particular circumstances of the case; but, for  
14 now, we will assume it is correct. In that case, a key element of the restoration of the status quo  
15 is to compel the polluter to surrender the profit he gained by not complying with the law. This is  
16 essentially what the EPA Penalty Policy focuses on by virtue of the prominent position it accords  
17 to the calculation of economic benefit.

18 It should be noted, however, that removing the economic benefit is not the *only* action  
19 that might be required in order to restore the status quo. This is because the failure to comply  
20 with a federal regulation may entail not only an unwarranted gain to the violator but also an  
21 unwarranted loss to some other party. In the case of violation of an economic regulation, for  
22 example, a violation of anti-trust law may generate not only an unlawful gain to the seller but  
23 also an unwarranted loss to the customers who purchase from this seller. In that case, the  
24 restoration of the status quo requires not only that the seller surrender his unlawful gain but also  
25 that the customers be compensated for their unwarranted loss. With a violation of an  
26 environmental regulation, while there may not be an unwarranted monetary loss to a third party,  
27 there is a non-monetary loss resulting from the polluter's action in the form of some harm to the  
28 natural environment, at least if the violation involves releases to the environment. Whether the  
29 natural resource that is harmed belongs to a private individual or the general public, a loss has  
30 occurred, and restoration of the status quo calls for some appropriate compensatory action.  
31 Depending on the circumstances, this action could include both clean-up and some form of



1 environmental restoration.<sup>1</sup> The costs of clean-up and environmental restoration are thus  
2 compensation that should be paid by the polluter in order to restore the status quo.

3 The popular name for what is being discussed here is “the polluter pays principle.” Not  
4 only is this called for by notions of fairness, but also it is supported by considerations of  
5 economic efficiency. Ever since Pigou (1918), it has been recognized that, in the presence of a  
6 harmful externality such as that caused by pollution, a competitive market is generally unlikely  
7 to lead to a socially optimal allocation of resources unless the polluter is required to bear the cost  
8 that his pollution imposes on others.

9 In summary, the restoration of the status quo would appear to be an important aspect of  
10 the fairness objective in setting the penalty for a violation of an environmental regulation. This  
11 restorative goal can be seen to have two possible implications. If one focuses on the polluter’s  
12 unlawful gain, restoration of the status quo implies that he should give up this gain. If one  
13 focuses on the unlawful harm to the environment, restoration of the status quo implies that he  
14 should pay an amount covering the cost of cleanup and/or environmental restoration. In general,  
15 there is no reason to expect that the two different approaches will lead to a similar assessment of  
16 a monetary payment: the cost avoided by failing to control pollution need bear no relationship to  
17 the damage caused by the pollution. This raises two questions: Which approach is presently  
18 adopted by the EPA? Which approach seems preferable, or should they be combined in some  
19 manner?

20 With regard to the first question, it must be recognized that the current EPA penalty  
21 policy does contain some elements of both approaches, but they are combined in a manner that is  
22 equivocal and perhaps somewhat muddled. The first step in the penalty assessment process, the  
23 calculation of economic benefit, focuses on the unlawful gain to the polluter. The second step,  
24 the assessment of the gravity component, contains elements that clearly relate to the unwarranted  
25 loss to the environment, specifically item (i), the actual or possible harm. But, the  
26 characterization of this item is somewhat confusing because, while it includes factors that relate

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<sup>1</sup> With respect to the latter, although the context is different, it strikes us as relevant to quote the language used by the Department of Interior (DOI) in its proposed regulations for natural resource damages under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA). DOI describes the measure of damages as: “the cost of restoration, rehabilitation, replacement, and/or acquisition of the equivalent of the injured natural resources and the services those resources provide, *plus the compensable value of the services lost to the public for the time period from the discharge or release until the attainment of the restoration, rehabilitation, replacement and/or acquisition of equivalent of the resources and their services to the baseline* (italics added).” (56 Fed. Reg. at 19,769 (proposed 43 C.F.R. § 11.80(b)).

1 directly to the magnitude of the environmental damage -- the amount of pollutant, the toxicity of  
2 pollutant, the sensitivity of the environment, and the length of time of a violation – it also  
3 includes a factor (the size of the violator) that has nothing to do with the amount of  
4 environmental damage. We see the size of the violator as being relevant to the deterrence  
5 objective of a penalty rather than the restoration of the status quo.

6 In short, the current EPA penalty process appears to focus overwhelmingly on the  
7 calculation of the unlawful gain to the polluter, with no systematic consideration of the monetary  
8 value of the environmental damage caused by the violation of the pollution control regulation.  
9 We return to this issue in Section 6, below.

10 The deterrence objective is certainly recognized in the EPA’s penalty process. In addition  
11 to the item in the gravity component stage, noted above, the third stage of the process, the  
12 adjustment stage, is heavily weighted to factors that bear on deterrence, including the degree of  
13 willfulness and/or negligence, the extent of cooperation through pre-settlement action, the  
14 history of noncompliance, and the polluter’s ability to pay. But one consideration that plays a  
15 substantial role in the economic theory of deterrence appears to be entirely missing from the  
16 current penalty assessment process; this is the probability of detection and punishment associated  
17 with the violation in question. Economic theory indicates that, to obtain a given degree of  
18 deterrence, the penalty should vary inversely with the probability of detection: given two  
19 possible violations with the same economic benefit to the polluter but where one is much less  
20 likely to be detected than the other, the former requires a larger penalty in order to provide the  
21 same degree of deterrence. We also return to this question in Section 6, below.

### 22 **3.3. Delayed and Avoided Compliance Costs and the BEN Model**

23 Since 1978, a key EPA objective in assessing civil penalties has been to deter violators.  
24 The “cornerstone” of achieving this goal is to recapture the economic benefit that accrues from  
25 noncompliance. The BEN model, first issued in late 1984, was developed to calculate the  
26 economic benefits that result from cost-savings during the time that a facility is not in  
27 compliance. It can estimate savings from deferred capital investments in control equipment,  
28 deferred one-time expenditures (such as establishing accounting/tracking systems), and reduced  
29 recurring costs of maintaining and operating control systems.

1 The model is simple to run, requiring the user to provide a minimal amount of information  
2 to estimate cost-savings. Standard values, for things such as tax rates, the cost of capital, and  
3 equipment life are embedded in the model itself (although they can be modified by the user), and  
4 are determined by the user's response to a set of "screening questions." Since the BEN model  
5 became a central tool in the penalty assessment process, aggregate annual penalty assessments  
6 have risen dramatically. It is not possible to entirely untangle the impact of BEN from the  
7 impact of changes in EPA enforcement policies, but it seems apparent that BEN has been a  
8 factor in this increase.

9 BEN is presently limited to calculating the difference in discounted cash flows that result  
10 from cost-savings during noncompliance. Thus, it is not now configured to support recapture of  
11 benefits that could result from higher revenues. Viewed as a calculator, however, there is no  
12 inherent reason that BEN could not be used to estimate the benefits of higher revenues. This  
13 would require construction of specific questions for the user, parallel to the present questions  
14 that prompt the user to enter relevant information regarding differences in costs that result from  
15 noncompliance. We suggest such questions in Section 4.5 below.

16 In cases where greater revenues might be a significant incentive to be non-compliant,  
17 adding questions that would support estimation of differences in discounted *net* cash flows  
18 would be useful and, in fact, critical to deterrence.

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### 20 **3.4 The Four Categories of Illegal Competitive Advantage**

21 The White Paper identifies four categories of cases in which the economic gain of  
22 noncompliance with an environmental regulation is said to go beyond the benefit of delaying or  
23 avoiding compliance costs. It refers to these as "Illegal Competitive Advantage" (ICA). It also  
24 provides examples and counterexamples of each category and briefly describes how the  
25 economic gain can be calculated. The four categories of cases are:

- 26 - violator gains additional market share;
- 27 - violator sells products or services prohibited by law;
- 28 - violator initiates construction or operation prior to government approval; and
- 29 - violator operates at higher capacity than it should have.

1           **3.5 The Charge Questions for The Panel**

2           The specific charge questions are:

3           1.       Are there categories of cases that would be useful for the Agency to consider in  
4 calculating the ICA economic benefit, other than those that are identified in the White Paper?  
5 Should any of these be combined?

6           2.       How can the Agency more accurately characterize the types of cases that are  
7 described in the White Paper? Have any of the examples and counter-examples in the White  
8 Paper been misidentified with regard to whether they are amenable to the BEN model's  
9 simplifying paradigm?

10          3.       Are there any suggestions for modifying the described analytical approach to  
11 calculate the economic benefits and;

12          4.       The Agency's proposed approach strives to avoid double-counting of the benefit  
13 by laying out all relevant cash flows stemming from the violations, as opposed to simply adding  
14 on the additional calculations to a BEN run. What additional measures (if any) should the  
15 Agency put in place to avoid such potential double-counting?

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## 4. THE PANEL'S RESPONSES

### 4.1 The Economic Benefit is the Increase in Profits<sup>2</sup>

The fundamental question for the determination of the economic benefit component of the penalty is ... how much the profits of the firm have increased or will increase as a result of its noncompliance? Profits can be increased either by an increase in revenue or a decrease in the total cost of production (including abatement costs), or some combination of both. The BEN model provides a reliable measure of the change in after-tax profit only if no other change would have occurred that would have affected the firm's profit. This is an empirical question that should be explored and not assumed.

The Agency's White Paper has essentially placed all of the other factors that might influence the amount by which the violator's profit was increased by the violation in one of the four categories under the heading of "benefit from illegal competitive activity." For several reasons, the Panel finds that the Agency's use of the term "illegal competitive advantage" and its identification of the four categories of ICA cases is unhelpful.

1. It is not clear what the modifier "competitive" is intended to convey.

2. Increases in market share will often be difficult to identify in terms of comparing the noncompliance scenario with the unobserved counterfactual compliance scenario; and observed increases in market share might be difficult to attribute exclusively to the noncompliance.

3. In any case, increases in market share are not inherently valuable to the firm; what matters is the impact of changes in market share on profits.

4. The other categories of ICA appear to be unusual circumstances that are very context dependent.

The Panel believes that it would be more transparent to have only two categories of benefit from noncompliance: (i) firms experienced no revenue increase and violators' profits were

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<sup>2</sup> The Panel's responses to the specific charge questions are in Section 4.4 below.

1 increased by the amount of the delayed or avoided compliance costs; and (ii) firms gained profits  
2 from increased sales.<sup>3</sup> The BEN model would be applicable for those cases that fit into the first  
3 category. For all other cases, we recommend that the Agency examine the facts of each case and  
4 use methods and data appropriate to the case to estimate the changes in streams of revenue and/or  
5 production costs as well as delayed or avoided compliance costs (if any). As already noted, the  
6 Panel believes that BEN can be modified to deal with estimates of increased revenues.

#### 7 **4.2 Economic Benefit When Revenues Change Due to Noncompliance**

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9 When non-compliant firms do sell more than they would have if they had complied, their  
10 economic benefit includes the profits they earn on the increased sales. A key point of potential  
11 confusion is whether (or when) profits on increased sales should be added to avoided/delayed  
12 costs as opposed to being a substitute measure of economic benefit.

13 Figure 1, which shows the effect of noncompliance on the profits of a firm operating in a  
14 competitive industry, illustrates the issues. The horizontal line at the level PM indicates the  
15 competitive market price.<sup>4</sup> The two upward-sloping lines represent the marginal cost when the  
16 firm complies and when the firm does not comply with environmental regulations. The graph is  
17 based on the assumption that noncompliance lowers marginal cost, which is why the marginal  
18 cost curve for noncompliance is the lower of the two curves. When the firm complies, its profit-  
19 maximizing output is QC, the output where the marginal cost (given compliance) equals the price  
20 set in a competitive market. When it does not comply, its lower marginal cost curve induces it to  
21 sell a higher output, QN.

22 Under compliance, profits are given by triangle A.<sup>5</sup> Under noncompliance, they are the  
23 sum of areas A, B, and C. The economic benefit is, therefore, the sum of areas B, and C. The  
24 cost avoided by noncompliance of producing QN is the sum of areas B, C, and D, which exceeds  
25 the increase in profits from noncompliance by Area D.

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<sup>3</sup> It is conceivable that in the long run a noncomplying firm could gain sufficient market power to enable it to increase profit by reducing output and raising price. But we think that this is a remote possibility.

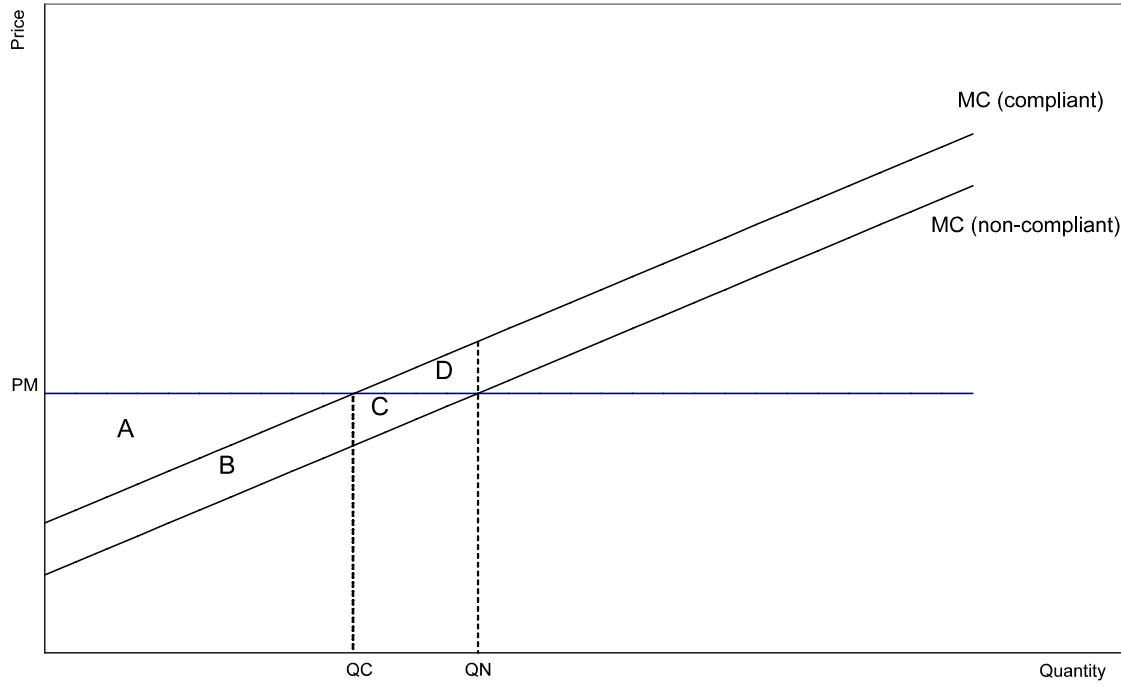
<sup>4</sup> The line is horizontal because the firm, by assumption, operates in a perfectly competitive industry, which means that its output does not affect the market price.

<sup>5</sup> This assertion assumes that there are no fixed costs. With fixed costs, the graph gets more complicated, but the basic principle remains the same. Avoided cost at the level of output actually produced overstates the gain from noncompliance.

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Figure 1

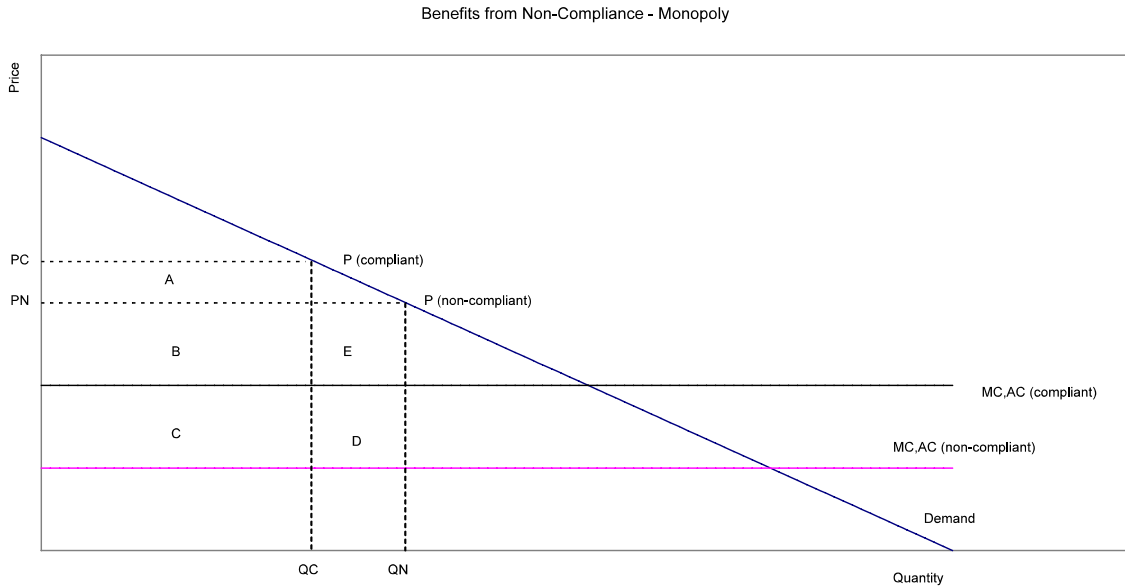
Benefits from Non-Compliance - Competition



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Figure 2



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3           The principle that delayed and avoided cost overstates the change in profits is not  
4 restricted to firms operating in perfectly competitive markets. As Figure 2 shows, it also applies  
5 to monopolists and firms operating in monopolistically competitive industries. In Figure 2, the two  
6 solid horizontal lines represent unit costs when the firm is and is not in compliance with EPA  
7 regulations.<sup>6</sup> QC and PC are the profit-maximizing quantity produced and price charged when  
8 the firm is in compliance while QN and PN are the profit-maximizing quantity and price when the  
9 firm is not in compliance. The graph represents the case of a monopolist or a monopolistic  
10 competitor. Again, noncompliance lowers marginal cost and therefore causes the firm to produce  
11 more than it otherwise would.

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6           The graph as drawn is based on the assumption of constant returns to scale both with and without compliance. That assumption simplifies the graph because it implies that marginal and average cost are equal to each other.



1 When the firm complies with regulations, its profits are the sum of areas A and B. When  
2 it does not comply, its profits are the sum of B, C, D, and E. The economic benefit is, therefore,  
3 the difference between the two, or  $C + D + E - A$ . This benefit is difficult to calculate, because  
4 all that is observed is the actual prices and quantities (QN and PN). Calculating the true  
5 economic benefit requires estimating the quantities that would have been produced, and the prices  
6 that would have been charged, if the firm had complied (QC and PC).<sup>7</sup>

7 If instead of calculating the true economic benefits to the violator, the EPA used avoided  
8 costs at the quantity actually produced, that measure in Figure 2 would be areas C + D. This  
9 avoided cost measure differs from the true measure by the amount  $A - E$ . It is a general  
10 proposition in economics that A is greater than E. (If it were not, a compliant firm could make  
11 more profits by producing QN than QC.) Thus, using avoided costs at the actual quantity  
12 produced (i.e., C + D) overstates the true economic benefits of noncompliance (i.e.,  $C + D + E -$   
13 A), since  $E - AD$  is negative.

14 There are two situations in which a calculation of economic benefit based on  
15 avoided/delayed costs could still be justified. The first is if it can be assumed that the effect on  
16 output is sufficiently small that the error induced by ignoring output effects is also small. This  
17 might occur if the firm has quasi-fixed capital, meaning that it cannot increase its level of  
18 economic activity, at least in the short run. The second is if compliance would affect fixed costs  
19 only. In that case, compliance would leave marginal cost and, accordingly, output unchanged.

20 Figure 2 can also be used to analyze cases in which output would be 0 under compliance,  
21 which would be the case if the MC (= AC) for compliance lay above the vertical intercept of the  
22 demand curve. The areas A, B, C, and E would disappear. Area D, the area between the MC (=   
23 AC) for compliance and the MC (= AC) for noncompliance out to the quantity QN, is the measure  
24 of cost savings at the observed level of output. This an overestimate of the economic gain, which  
25 is the net revenue given by the area PN times QN less MC (Noncompliant) times QN. This class  
26 of cases includes those when a firm sells illegal output. It also covers many cases involving  
27 illegal development of wetlands.

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This analysis is partial equilibrium in nature. That is, it ignores the effects of price changes on other parties, for example those who purchase the firm's products or supply factor inputs to it. There might also be effects in markets for substitute or complimentary goods. For purposes of establishing penalties as incentives for compliance, only those changes that affect the noncomplying firm need to be considered.

### 4.3. The Four Categories of Illegal Competitive Advantage

In this section we consider each of the four categories of ICA in more detail and offer comments on the appropriate methods for estimating economic benefit.

#### A. Violator Gains Additional Market Share

In this case, a violator gains market share by offering a price to the market that compliant competitors cannot match. This is possible because failure to comply lowers costs, allowing the firm to under-cut the market price. The presumption is that a gain in market share then leads directly to higher net revenues. Profits might not increase, however, even with higher revenues if the non-compliant firm also experienced unexpectedly higher unit costs at a higher level of output. This could result from overtime payroll expenses or a decline in quality control, for example. Further, compliance costs are typically a small share of operating costs and unlikely to support long-term under-cutting of the market price. Consequently, a case that considers only changes in market share is not useful in determining whether there was economic gain as a result of the violation.

Example #1 in the White Paper (a firm bidding on a cost-plus contract) is highly contrived as it brings together elements that would not generally be observed in one case. As a result of a cost advantage from noncompliance, a company that is subject, in effect, to *minimum* price regulation charges a lower price than it otherwise would and obtains a contract it would not have gotten.<sup>8</sup> The experience gained from the contract helps it get future business. The set of facts seems unlikely because most price regulation is maximum price regulation and because price regulation tends to arise in monopoly markets.

The discussion in the White Paper through the bottom of page 14 of how to deal with the profits from the contract in Example #1 is appropriate. The remainder of the discussion in that section is highly speculative because of the problems in translating increases in market share into

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<sup>8</sup> "Minimum price regulation" is a price floor, meaning that a company could not charge less than the regulated price even if it wanted to. Most price regulation, such as the regulation of public utilities, sets a maximum or a ceiling on what price a company can charge. (Even when a regulatory agency sets an exact price that is technically both a floor and a ceiling, the rationale is usually to prevent the company from charging more.)

1 increases in profits. It is not likely to form the basis for practical, defensible calculations of  
2 economic benefit.

3 It is of interest to consider separately the issue of a firm subject to cost-based price  
4 regulation. An electric utility would be a possible example. If it charged a lower price as a result  
5 of not complying with environmental regulations, noncompliance would increase the quantity of  
6 electricity sold. Again, avoided cost would tend to overstate the economic benefit the utility  
7 gained because it would ignore the fact that the cost-based regulation would allow the utility to  
8 pass the cost on to customers. (In practice, prices in cost-based regulations do not necessarily  
9 adjust immediately to cost changes. One exception, though, is fuel-price adjustment clauses,  
10 which could come into play if a utility used a lower-cost but higher-polluting fuel source.)

11 B. Violator Sells Products or Services Prohibited by Law

12 Customers might prefer, based on correct or incorrect information, to use a product that  
13 has been prohibited, such as leaded paint, Freon, or certain pesticides with limited legal  
14 application. Non-compliant firms that produce or sell these products would then gain revenues by  
15 selling products that compliant firms do not offer to their customers. Such products might well  
16 cost more to provide, but customers might be willing to pay a higher price to obtain products that  
17 they perceive will meet their needs better than compliant products. The economic benefit is the  
18 profit on the sales.

19 C. Violator Initiates Construction or Operation Prior to Government Approval

20 This case involves premature sales, which are analogous to sales of an illegal product.  
21 The sales are illegal in the period before the permit is obtained. The approach recommended in  
22 the White Paper is theoretically correct but likely to be difficult to implement in full generality.  
23 In practice, the period of time over which noncompliance has an effect should be limited. But it  
24 need not be limited to the head-start period. For example, suppose a company begins operations 6  
25 months before it is allowed to and that it typically takes 1 year to attain full market penetration.  
26 The head start would affect the level of sales up to the point when full penetration would have  
27 been obtained under compliance. The longer the hypothesized effect, the more speculative the  
28 estimate becomes. Attempts to link permanent changes in market share to the head start are likely  
29 to be too speculative to withstand scrutiny.

1 D. Violator Operates at Higher Capacity Than It Should Have

2 The case hypothesizes that the company installs durable capacity that is non-compliant but  
3 that it is allowed to use the capacity. As with example 1, the hypothesis seems contrived.  
4 However, if such a case were to arise, it would be useful to ask whether noncompliance resulted  
5 in sales that it could not have made legally, or could it have generated the same level of sales at  
6 higher cost. If the sales could not have been made legally, then the economic benefit is the profits  
7 on the increased sales. If they could, then benefit could be measured as avoided cost. The  
8 conceptual problem with doing so is that the higher level of sales might have proven unprofitable  
9 if the firm had to incur the costs associated with compliance.

10 If the firm makes sales it could not have made legally under compliance, then the profits  
11 on the illegal sales are part of economic benefit. The White Paper is correct that BEN can be used  
12 if there would have been a legal but higher cost way to make those sales. If an economic benefit  
13 calculation does have these two pieces, then it is important that the avoided costs be limited to the  
14 avoided costs of producing the output that would have been legal under compliance.

15 **4.4. Direct Responses to Charge Questions**

16 Our answers to the four charge questions are as follows:

17 **1. Are there categories of cases that would be useful for the Agency to consider in**  
18 **calculating the ICA economic benefit, other than those that are identified in the White**  
19 **Paper? Should any of these be combined?**

20 We do not think that the categories offered in the White Paper are particularly useful. In  
21 fact we believe that they should be combined into only one category - cases where profits increase  
22 at least in part due to increases in revenue.

23 **2. How can the Agency more accurately characterize the types of cases that are**  
24 **described in the White Paper? Have any of the examples and counter-examples in the**  
25 **White Paper been misidentified with regard to whether they are amenable to the BEN**  
26 **model's simplifying paradigm?**

1 As indicated above, we do not think that the categorization of cases in the White Paper is  
2 useful. However, the White Paper is correct in its statements about whether specific cases can be  
3 analyzed within the BEN framework as that calculation software is currently configured.

4 **3. Are there any suggestions for modifying the described analytical approach to**  
5 **calculate the economic benefits?**

6 We believe that there is no substitute for a careful examination of the facts of each case  
7 and the use of methods and data appropriate to each case to estimate the changes in streams of  
8 revenue and/or production costs as well as delayed or avoided compliance costs (if any).

9 **4. The Agency's proposed approach strives to avoid double-counting of the benefit**  
10 **by laying out all relevant cash flows stemming from the violations, as opposed to simply**  
11 **adding on the additional calculations to a BEN run. What additional measures (if any)**  
12 **should the Agency put in place to avoid such potential double-counting?**

13  
14 Every effort should be made to calculate economic advantage as avoided/delayed costs  
15 (and therefore not to decompose the gain into separate components.) One should only resort to a  
16 full-blown change-in-profit analysis when using avoided/delayed costs leads to a clearly  
17 substantial overestimate or underestimate of the economic benefit. If it is necessary to do  
18 change-in-profit analysis, it is important that the estimate of costs under compliance reflect the  
19 lower level of output the firm would have produced rather than the actual production of the  
20 polluter.

21 **4.5. Revising the White Paper**

22 We recognize that if the foregoing recommendations are accepted, it will be necessary for  
23 the EPA to revise significantly the White Paper. We suggest that this be done in the following  
24 manner. The Paper should start with the observation that the fundamental question for the  
25 determination of the economic benefit component of the penalty is how much did the profits of  
26 the firm increase as a result of its noncompliance. Profits can be increased either by an increase  
27 in revenue or a decrease in the total cost of production (including abatement costs), or some  
28 combination of both.

1 To determine the nature of the economic gain, we propose the following screening  
2 questions:

3 (a) *Did the violation lead to an increase in sales volume and/or revenue that would not*  
4 *otherwise have occurred?*

5 If the answer is “No,” then economic gain is limited to avoided/delayed costs, and the  
6 BEN Model can be used. If the answer is “Yes,” then:

7 (b) *Was there an increase in revenue but not in volume?* (The answer to this question is  
8 likely “No.” For the answer to be “Yes,” the violator would have had to sell the same volume but  
9 charged a higher price, perhaps because the violation was to add an illegal ingredient that made  
10 the product more effective.)

11 If the answer to (b) is “Yes,” then the BEN model as presently configured is not  
12 appropriate for computing economic gain. It is necessary to estimate the increase in revenues as  
13 well as the avoided/delayed compliance cost.

14 If the answer to (b) is “No,” then the firm must have sold units of output that it would not  
15 have sold if it had complied with EPA regulations. As explained in Section 4.2, in such a setting  
16 avoided/delayed compliance cost overstates the true economic benefit of noncompliance, at least  
17 in competitive and monopolistic markets.

18 It might nonetheless be appropriate to estimate economic benefit as avoided/delayed costs  
19 if there was nothing inherently illegal about the sales themselves. To ascertain whether that is  
20 correct, a “Yes” to (A) and a “No” to (B) should be followed by:

21 (c) *Could the firm have made these incremental sales legally and complied with*  
22 *regulations?* (If the firm sold an illegal item, the answer should be “No.” If the firm simply  
23 chose a higher level of output because of its cost-savings from failing to comply, it should be  
24 “Yes.”)

25 If the answer is “No,” then the BEN model is not appropriate for computing economic  
26 gain.

1           If the answer to (c) is “Yes,” then in principle, use of the BEN model is inappropriate.  
2           However, as explained in Section 4.2, if it can be assumed that the effect on marginal cost and  
3           output is sufficiently small that the error induced by ignoring output effects is small, then  
4           avoided/delayed cost can be taken as a reasonable approximation of economic benefit.

5  
6           In order for the OECA to implement our recommendations, it will have to have access to  
7           the relevant expertise in economics. One possible source of this expertise in the Agency is the  
8           National Center for Environmental Economics (NCEE). But it might be more useful to OECA to  
9           have its own in-house economist. This would be especially true if the agency accepts our  
10          recommendations in Section 6.4 for rethinking the civil penalty policy.

## 5. ADDITIONAL ISSUES

### 5.1. The Effect of Market Structure

The analysis of Section 4.2 showing that measures of delayed and avoided cost overstate economic benefit when output is increased because of lower costs holds for both monopoly and competitive market structures. Whether the point is true in oligopoly is less clear. In the frequently-used Cournot model, avoided and delayed cost on the actual level of output understates the gains companies get from not complying. However, there are other oligopoly models, such as the Bertrand and Stackelberg models, in which avoided and delayed costs overstate the economic benefit from noncompliance, as is the case with monopoly and perfect competition.<sup>9</sup> Cases might arise in which the Agency would want to compute profits from increased sales based on an underlying model of oligopoly. As the appropriate choice among competing models would likely depend on the details of the violator's industry, however, the committee cannot recommend a standard approach. Any estimate of economic gain from noncompliance based on an oligopoly model is likely to be controversial and harder to defend in court than an estimate of avoided or delayed cost. Thus, the EPA should only attempt such estimates when it believes that the profits on increased sales are substantial.

### 5.2. Dynamic Effects

To this point, we have implicitly assumed that economic benefit from noncompliance arises during the period of noncompliance. There are a variety of reasons, however, why noncompliance could have enduring effects. The violator might gain customers who remain loyal. There might be "learning curve" effects that give it strategic advantages in future periods.

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<sup>9</sup> Modeling oligopolistic markets raises fundamental issues of economic logic. In general, forcing a firm to pay what it would have cost to comply given its actual level of output leaves it with the profits it would have had if it complied and it chose that same level of output. If it had complied, however, it would not have chosen that output because the profits it generates are lower than it could get with a different output. This logic breaks down in oligopoly models in which firms make incorrect conjectures about the responses of rivals. In the Cournot model, any one firm could make higher profits by increasing its output. A reduction in marginal cost due to noncompliance then induces it to do what it should have done anyway – expand output. The different result for the Bertrand model is because each firm starts by producing too much rather than too little. A marginal cost reduction from noncompliance would cause the firm to produce still more and move to even lower profit levels. For further discussion of these oligopoly models see one of the standard treatises, for example Shapiro (1989) or Tirole (1988).



1 It might be involved in an industry in which market saturation takes time. If noncompliance  
2 allows it to enter the market earlier than it would have, it might move forward the entire diffusion  
3 path.

4 The presence of dynamic effects does not alter the point that avoided/delayed costs over-  
5 estimate economic gains when the polluter increases sales because of lower marginal production  
6 costs from the noncompliance. This point follows from the general logic of optimization.  
7 Forcing the firm to pay what it would have cost to comply with regulations at its actual output  
8 leaves the firm as well off as it would have been if it had chosen that output and complied.  
9 However, the firm might have done still better by choosing a different (presumably lower) output.  
10 Thus, the presence of dynamic effects does not cause avoided/delayed costs to understate  
11 economic advantage.

12 Dynamic effects create more of a problem for profits on increased sales as a measure of  
13 economic benefit. If the firm sells more by virtue of not complying and those sales increase  
14 future profits, then the value of those future profits is part of the economic gain from  
15 noncompliance. A case could arise, for example, in which a company gets an unexpectedly large  
16 order from a valued customer. Had it anticipated the order, the company could have made the  
17 investments needed to fill the order and comply with environmental regulations. Having not  
18 anticipated the order, however, it must either violate environmental regulations or risk losing  
19 subsequent business.<sup>10</sup> One might compute the economic gain from the violation as profits on  
20 increased sales, but the proper measure would include profits on future sales, the extent and  
21 duration of which might be hard to measure. An easier approach might be to determine what it  
22 would have cost to bring the plant into compliance for the level of activity that actually occurred.  
23 (Even if the notice on the order was so short that it was not physically possible to comply prior to  
24 filling the order, one might estimate the economic gain as what compliance would have cost if it  
25 did have sufficient notice.)

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10 In public comments, Jasbinder Singh, President of Policy, Planning & Evaluation, Inc. of Herndon, VA (2004) recounted one such case to the Panel. In that case, an automobile parts paint company violated environmental regulations while satisfying an unexpectedly large order from Chrysler. See also Singh (1999, and 2000).

1 **5.3. *Ex Ante* vs. *Ex Post* Assessments**

2 A conceptual issue is whether the economic benefit from noncompliance should be  
3 measured as the benefit the violator expects at the time it decides not to comply or the benefit it  
4 actually realizes. (In economic terminology, the former is referred to as the *ex ante* benefit  
5 whereas the latter is the *ex post* benefit.) These can be quite different. For example, suppose a  
6 company illegally develops a wetlands to start a business that turns out to be unprofitable. This  
7 would be an example of case 2 in the White Paper. If the benefit is computed as the *ex post*  
8 profits actually earned, the economic benefit recapture portion of the penalty would be zero. Yet,  
9 the company presumably developed the business because *ex ante* it expected it to be profitable, so  
10 it did expect to get a benefit at the time it decided to violate the law. Of course, the *ex ante*  
11 benefit may also be lower than the *ex post* benefit. In the wetland example, this case would occur  
12 when the development earned higher profits than expected. Enforcement personnel should avoid  
13 simply selecting the method that results in the largest or smallest penalty.

14 Panel members debated whether and when *ex ante* penalties would be more appropriate  
15 than the *ex post* version. Most members could envision cases in which an *ex ante* penalty would  
16 be more desirable, either for fairness or deterrence reasons, but the panel was unable to formulate  
17 general rules that would arguably cover all possible decision situations for EPA. Therefore, the  
18 panel considers its advice on this subject to be cautionary. The Agency should recognize that the  
19 standard *ex post* approach will not fit every penalty context.

20 To the extent that a violator should pay a penalty based on its expected rather than its  
21 realized economic benefit from a violation, the Panel recognizes the practical question of how to  
22 estimate what that *ex ante* amount was. One possibility suggested was for EPA to base an  
23 estimate on evidence from any business plan that justified the action taken to executives and  
24 board. A second suggestion was to examine the average profits earned from comparable  
25 ventures, whether or not these involved violations of environmental regulations (legal wetland  
26 development activities, for example). Where the benefit from the violation was arguably a  
27 reduction in the risk to the firm, it could be measured in the insurance market from premiums  
28 avoided. Without knowing in advance what information will be available for an assessment of *ex*  
29 *ante* benefit, it is difficult to judge the adequacy of these suggestions.

## 6. TOWARD AN OPTIMAL PENALTY POLICY

### 6.1 Economic Theory of Optimal Penalties

As explained in Section 3.2, the EPA Penalty Policy sets the goals of fairness and deterrence as primary objectives in the determination of a civil penalty. Here we wish to discuss these objectives and the larger question of the approach to the determination of a civil penalty in the light of the economic theory of “optimal” penalty, originally developed by Becker (1968) in the context of criminal punishment, and subsequently elaborated in a large body of economic literature applying the notion to civil penalties as well, including penalties for environmental offenses (see e.g., Cohen, 1992 and 1999).

The economic theory of optimal penalties approaches the issue of deterrence from the perspective of economic efficiency rather than that of fairness. This theory makes two points that are relevant to EPA’s Penalty Policy. The first is based on the assumption that potential offenders respond to both the probability of detection and the severity of punishment if detected and punished. Thus, deterrence may be enhanced by raising the penalty, by increasing monitoring activities to raise the likelihood that the offender will be caught, or by changing legal rules to increase the probability of punishment. And second, the economically optimal penalty balances the harm done by an offense against the cost of deterring the offense in one or another of these ways. This balancing leads to the conclusion that the appropriate methodology for calculating a penalty is to charge an amount per offense equal to the (monetized) harm done divided by the probability of punishment (see Becker, 1968). This makes the expected value of the penalty equal to the harm.

It is worth emphasizing that this optimal penalty is based on the “harm” caused by the offense, not the “gain” to the offender. To take a simple criminal example, if a mugger obtained \$100 in a robbery and the victim ended up spending three days in the hospital, a penalty based on the \$100 gain to the offender would surely be too low – and would “under-deter” such offenses. In the context of environmental offenses, suppose a firm fails to install a \$100 safety valve and as a result 10,000 gallons of crude oil spilled into a sensitive coastal area. The \$100 “gain” to the offender would certainly not be an appropriate starting point for a penalty. On the other hand, if

1 the savings due to noncompliance were large relative to the harm, a harm-based penalty would  
2 not deter noncompliance. But since the gain from noncompliance exceeds the harm,  
3 noncompliance is the overall socially efficient outcome.

4 Alternatively, if the goal is to deter every violation of the law (“absolute deterrence”),  
5 then a gains-based penalty is appropriate. We could impose a penalty equal to the gain to the  
6 offender divided by the probability of detection and punishment. Then it would never be in the  
7 potential offender’s interest to violate the law. Some offenses – like violent assaults and rapes –  
8 are of this nature (economists sometimes refer to these as “unconditionally deterred” offenses) -  
9 society would never condone these offenses regardless of the private benefit to the offender.  
10 However, pollution is usually a byproduct of a socially beneficial activity. In the jargon of the  
11 law and economics literature, pollution is a “conditionally deterred” offense – one that we only  
12 want to prohibit when its social costs exceed its social benefits. If the expected penalty greatly  
13 exceeds the expected benefit to the offender and yet the harm from the offense is relatively minor,  
14 the result will likely be “over-deterrence.” On the other hand, as suggested in the example in the  
15 previous paragraph concerning the under-deterrence of a mugging offense, and as Polinsky and  
16 Shavell (1994) show more generally, if the enforcement agency underestimates the gain to the  
17 violator, that makes it more profitable to violate the law. Thus, gain-based penalties are more  
18 susceptible to under-deterrence than harm-based penalties, because, even if harm is  
19 underestimated, the offense is still likely to be deterred if it is very harmful.

20 Thus, conceptually, if the goal of environmental policy were economic efficiency, the  
21 EPA enforcement office should start with an examination of both the harm and the probability of  
22 punishment. To do so would require relatively good data on both these elements – which are  
23 difficult and sometimes impossible to quantify. We are aware that many of the statutes governing  
24 EPA appear not to make economic efficiency the goal but rather imply a goal of absolute  
25 deterrence of polluting activities.

26 The next two sections deal with each of the two components of an optimal penalty – harm  
27 and probability of detection. Following that, we discuss the current EPA Penalty Policy that  
28 focuses primarily on “gain” instead of “harm,” and examine what features of that policy might be  
29 improved upon.

1           **6.2. Quantifying Harm**

2           If an environmental violation results in emissions levels that are beyond a legal standard,  
3 there is likely to be some harm to natural resources or human health. Over the past 40 years,  
4 economists have developed a variety of techniques to measure these harms in monetary terms –  
5 including both revealed preference approaches (e.g., travel cost methodology) and stated  
6 preference approaches (e.g., contingent valuation). The field of non-market valuation has  
7 emerged as a major branch of environmental economics and there is a very extensive literature on  
8 the subject. Measuring people’s value for non-market items in monetary terms (e.g., measuring  
9 what they would be willing to pay to prevent a specific harm to the natural environment) is  
10 inherently difficult, and in practice different measurement techniques can produce different  
11 results (this is also true of market valuation). While the methodologies are now well developed  
12 and have been used extensively by government agencies for the cost-benefit assessment of public  
13 investment projects, the design of public policies, and the assessment of natural resource  
14 damages, the relevant methodologies do continue to evolve and there is some continuing  
15 disagreement about the relative merits of alternative approaches and their overall reliability.<sup>11</sup>  
16 Nevertheless, the Panel believes that the state-of-the-art in benefits estimation has progressed to  
17 the point where EPA should seriously explore how it might incorporate “harm-based” measures  
18 into its penalty formula, at least for some types of environmental harm.

19           We recognize that while some of the methods used to value environmental harm can be  
20 employed with relatively little cost, others require significant resources. Thus, in many (if not the  
21 majority of) cases, these methods may not be practical unless the harm (and thus expected  
22 penalty) is extremely large. Harm-based measures might only be appropriate for a small number  
23 of cases. But these are likely to be the cases that result in very significant and quantifiable harm.  
24 Furthermore, since the EPA already makes extensive use of non-market valuation to assess the  
25 efficacy of its environmental protection programs and policies, it seems to us appropriate that the  
26 Agency should in principle be prepared to apply these same techniques, at least in some cases, to  
27 assess the value of the damage when the environmental laws are violated.

28           A possible approach would be to allow for use of “gain to the offender” in cases where  
29 harm is not easily quantified and the cost of estimating harm is too great. This approach is similar

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<sup>11</sup> For comprehensive presentations of the methods for valuing changes in environmental conditions, see Freeman (2003) and Champ, Boyle, and Brown (2003).

1 to that employed by the U.S. Sentencing Commission in determining the default fine tables for  
2 organizations punished for federal crimes (USSC, 2003: Chapter 8 – Sentencing of  
3 Organizations). However, they mandate the larger of harm or gain and specifically indicate that if  
4 one is hard to estimate, the court may use the other.

### 5 **6.3. Probability of Detection and Punishment**

6 The probability of detection is likely to vary considerably by type of violation and even  
7 across jurisdictions. By definition, the probability of punishment is bounded between zero and  
8 one. Using the optimal penalty formula, this means that the optimal penalty is bounded by harm  
9 and an infinite multiple of harm. Taking the most simplistic case of a very large oil tanker  
10 accident, the probability of detection and punishment is likely to be one. Hence, the optimal  
11 penalty is simply equal to the harm. This suggests that the optimal penalty for an extremely  
12 harmful environmental violation is likely to be the monetary equivalent of harm – without  
13 inflating the harm by a multiple. However, as the size of the harm decreases, all else equal, we  
14 expect that the likelihood of detection also decreases.

15 Other factors that might influence the probability of detection and punishment are: (a)  
16 whether or not a violator is subject to mandatory reporting that is available to the public to  
17 scrutinize and file citizen lawsuits, (b) the ratio of facilities to inspectors in an EPA region, (c) the  
18 strength of environmental activism in a region/state, and (d) whether or not the violator had a  
19 history of violations and thus was subject to increased scrutiny or targeted enforcement.

20 An additional consideration in penalty calculations is that the offender may take actions to  
21 reduce the likelihood of detection. For example, an oil tanker might clean its tanks far at sea to  
22 evade detection by the Coast Guard. A firm that fails to meet permit standards might falsify  
23 mandatory reporting records. Inspectors might be bribed or their attention diverted with false  
24 emergencies or false leads. While these hypothetical examples are not exhaustive, they illustrate  
25 that the EPA (and/or the Court) might ultimately determine that evasive actions were taken to  
26 reduce the chance of being caught or prosecuted. Those actions would lead to lower detection  
27 probabilities and hence higher penalties under the optimal penalty framework.

1           Although not widely employed in the environmental literature to date, numerous  
2 techniques are available to estimate the probability of detection and punishment – depending  
3 upon the circumstances. For a detailed discussion of this issue, see Parker (1989: 578-81). One  
4 widely used method is the “time until capture” approach which is most appropriate for ongoing  
5 violations that occur over a period of time. Nash (1991) used this approach to estimate the  
6 probability of detection for four types of fraud violations enforced by the Federal Trade  
7 Commission – violations of FTC orders, violations of FTC regulatory standards, Truth-in-  
8 Lending case, and unfair business practices. Nash concluded that the appropriate multiple for  
9 these types of regulatory violation is approximately 4.0, indicating that the penalty should be four  
10 times the harm.

11           Another method - the “capture/recapture” approach has its foundation in estimating the  
12 number of animals in a given geographic area. When there are multiple sources of detection (e.g.  
13 government inspectors as well as private citizens monitoring self-report data), one can exploit the  
14 fact that there is some overlap between these multiple sources. By examining how many different  
15 offenses are observed between the two “inspectors” and how many are identical, one can estimate  
16 the total number of offenders in the population. For example, Froehlich and Bellantoni (1981)  
17 estimated that the probability of detection for oil spills greater than 10,000 gallons was 0.87,  
18 based on the combination of two independent sources of information.<sup>12</sup> Cohen (1987: 44-5)  
19 combined this with Coast Guard data indicating that they can identify the source of about 70  
20 percent of spills that are detected, to arrive at an overall probability of detection of 60 percent.

#### 21           **6.4. Implications for Current EPA Policy**

22           As discussed earlier, the current EPA Penalty Policy starts with the calculation of “gain” –  
23 i.e., estimating the amount that the offender saved by not complying with environmental  
24 regulations, and then adds a “gravity” component based in part on the harm from the offense.  
25 However, the policy does not provide for quantifying the “harm” in monetary terms and also  
26 ignores any explicit consideration of the probability of detection.  
27

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<sup>12</sup>

When the sources of information are not independent, the analysis is more complicated; but the method can still be used.

28 At least in those cases where economic efficiency is the objective of regulation, an  
29 alternative approach that might be explored by EPA would be to provide for a “base” fine that is  
30 predicated on the harm. If harm cannot be quantified, the base might either be “gain” or a  
31 “default” fine level that is specified by type of offense. For example, EPA might study average  
32 awards for interim lost use value by type of pollutant natural resource damage cases to arrive at  
33 an approximation of the harm per “gallon” or per “ton” of a particular pollutant or waste. This  
34 could be incorporated into a default harms-based fine table. But where the objective of regulation  
35 is some form of absolute deterrence, the base penalty should be based on the gain to the polluter  
36 due to noncompliance.

37  
38 In either case, the base fine would then be multiplied by a factor that is based on the  
39 probability of detection and a penalty being imposed.<sup>13</sup> As discussed above, in several settings,  
40 the appropriate probability is 1.0, or so close to that value that any difference could be ignored.  
41 Examples include really massive oil spills, whether in coastal waters or on the open sea (where  
42 they would most likely result from serious damage to the tanker hull), and wetland destruction for  
43 development purposes, where the evidence is by definition permanently in place. Another  
44 example would be self-reported violations where the violator explicitly comes forward and  
45 announces its violation, corrects any problems, and offers to pay the appropriate penalty. In fact,  
46 under EPA’s Audit Policy, violators who expeditiously self-report and remedy a violation are  
47 penalized on the basis of the BEN model and do not have to pay any gravity component -  
48 effectively yielding a multiple of one. For smaller oil spills and other sorts of discharges that are  
49 not necessarily detected automatically, Section 6.3 contains several examples and citations to the  
50 relevant estimation literature. These techniques are not too difficult to implement, and EPA  
51 should be in a position to gather relevant data.

52  
53 It must be acknowledged that if the probability of detection and imposition of a penalty  
54 is small, say 0.1 to 0.5, the penalty will be several times larger than the economic gain due to  
55 noncompliance. And this might raise concerns about the fairness of the penalty policy. But such  
56 low probabilities indicate that the Agency should seek ways to increase the probability of  
57 detection and imposition of the penalty by improved monitoring and/or changes in the legal rules  
58 governing the imposition of penalties.

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<sup>13</sup> This is similar to the approach taken by the U.S. Sentencing Commission (2003). Also see U.S. Sentencing Commission (1988) for draft guidelines for sentencing organizations that more explicitly identify harm and probability of detection as the controlling factors.



59

60 The more typical regulatory violations such as exceeding a point source pollution discharge  
61 permit can be divided into two broad classes: self-monitoring/self-reporting sources (where firms  
62 are required to submit periodic reports of measured discharges), and all other sources. For the  
63 self-monitoring sources, if we assume honest reporting, the probability ought to be one. But it is  
64 clear from the existence of citizen suits that state enforcement agencies lack the resources to find  
65 and penalize many types of reported violations. (These self-reports are different from the type of  
66 self-reported violations noted above where the offender essentially calls up the regulatory  
67 authorities and turns himself in.) The applicable probability is therefore less than one. How much  
68 less could be estimated by examination of the accumulated data and comparison with the data on  
69 violations pursued, whether by the state or by an NGO or citizen suit. This analysis could be done  
70 using a random sample of firms to reduce the burden of estimating the probability.<sup>14</sup>

71

72 For non-self-monitoring/reporting sources, the relevant probability can be derived from the  
73 rate of EPA (or state EPA) inspections, assuming that the inspections detect all violations. Some  
74 estimates along these lines have been made in the past (Russell, 1983). Estimates could be based  
75 on existing EPA and state data on regulated sources, permits, and inspections. It is not a trivial  
76 exercise and would require some further investigation and some informed assumptions about the  
77 duration of a typical violation, etc. However, while the data are not perfect, neither is there a need  
78 for 100% accuracy. Instead, the goal is to arrive at some realistic estimate of the probability for  
79 various offenses that can be applied uniformly to those offense types. In any case, we anticipate  
80 that the Agency would have to develop regulations and procedures for establishing the  
81 probabilities used for penalties.

82

83 The probability of detecting RCRA offenses might be more difficult to estimate. However,  
84 it might be possible to compare the number of known illegal dumpsites to the number of illegal  
85 “midnight” dumpers who are convicted of those offenses. If there are two different sources (e.g.,  
86 “informants” and those identified directly through other law enforcement surveillance), one might

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<sup>14</sup>

If reporting is not honest, the enforcement problem becomes much harder, since “audits,” in the usual sense of the word are not possible due to the ephemeral nature of the discharges. To find a real violation when there was reported compliance would require actual monitoring at a time coinciding with the reported compliance. The act of the monitoring, if observable by the source, would, one expects, eliminate the temptation to lie about the compliance state, and so, without an informant, catching lying would be impossible, though catching violations would not. The applicable probability for a violation would, as discussed just below, be based on the probability with which the discharges were subject to “surprise” measurement.

87 be able to use the “capture-recapture” method described above to estimate the probability of  
88 detection. Alternatively, one might need to resort to a default multiple that is the equivalent of (or  
89 higher than) other empirically derived multiples, based on the assumption that these violations are  
90 the most difficult to detect.

91  
92 Overall, for several situations that concern EPA, a probability close to or equal to one will  
93 be appropriate. But this will not be true in general for routine point source discharge permit  
94 violations because of the lack of effort going into monitoring, either of the discharges themselves  
95 or of the self-reports. On the other hand, the research required to find reasonable values for the  
96 probability for self-reporting sources by state ought to be straightforward, since the reports are  
97 likely to be stored somewhere, and there will also be some record of enforcement actions  
98 undertaken. For sources that do not self-monitor, the approach would be to attempt to estimate the  
99 probability that a randomly chosen source is visited and has its discharges sampled for a period of  
100 time that corresponds in some way to the permit terms.

101  
102 It should be emphasized that what is sought here is an approximate estimate of the general  
103 probability of detection, not a highly elaborate calculation tailored to all the specific details of the  
104 particular violation. This could well be handled in a practical manner by identifying a small  
105 number of different types of violation, each associated with a generic estimate of the probability of  
106 detection.

107  
108 EPA’s Civil Penalty Policy currently incorporates a few features that might proxy for the  
109 probability of detection and imposition of a penalty. Specific gravity components are (U.S. EPA,  
110 1984a: pp. 14-15):

111 I. Importance of the regulatory scheme – The policy indicates that violations that are more  
112 important to the regulatory scheme will receive higher penalties. The example  
113 given suggests that more important violations will be harder to detect in many  
114 situations. Thus, the fact that no warning label is contained on a product would be  
115 more important than a warning label that was simply too small. The existence of  
116 the small warning label makes detection easy – since the product has already been  
117 identified as being hazardous. Whether this one example is illustrative, and  
118 whether other cases are related to the detection probability is unclear.

119

120 II. Availability of data from other sources – If a record keeping or reporting requirement  
121 is violated and that is the only source of information, the probability of detection is  
122 much lower than if multiple sources of the same data are available elsewhere.  
123 Thus, this gravity component appears to be consistent with increasing the penalty  
124 when the likelihood of detection is smaller.

125  
126 Importantly, the policy also contains a provision that addresses the “general  
127 deterrent” effect of the calculated gravity component of the penalty (EPA, 1984a: 16). This  
128 provision states that in some cases, “the normal gravity calculation may be insufficient to effect  
129 general deterrence. This could happen if there was extensive noncompliance with certain  
130 regulatory programs in specific areas of the United States. This would demonstrate that the  
131 normal penalty assessment had not been achieving general deterrence.” Thus, even though there is  
132 no guidance on a proper multiple, there appears to be some understanding that detection  
133 probability needs to be taken into account. The Panel recommends that EPA begin to study the  
134 feasibility of formalizing these concepts and providing more explicit guidance on how to calculate  
135 penalties that take into account both the harm and probability of detection.<sup>15</sup>

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<sup>15</sup>

One public commenter (Fuhrman, 2004 and 2004a) questioned whether EPA had the legal authority to consider probability in setting penalties. But as noted in Section 3.2 above, deterrence has long been one of the objectives of EPA Penalty Policy. And the probability of detection and imposition of a penalty is a key factor in the deterrent power of a penalty policy. See also ACC (2004) and Manufacturers Ad Hoc Group (2004).

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**APPENDIX A - A MORE DETAILED DESCRIPTION OF THE SAB  
PROCESS AND PANEL REVIEW PROCEDURES**

This Appendix identifies process of Panel selection and formation.

**A.1 Request for Review and Acceptance**

In June 2002, the Office of Enforcement and Compliance Assurance (OECA) had requested that the Science Advisory Board review the OECA White Paper. After considering all requests for 2004, the Science Advisory Board determined that the review should be conducted by a specialized panel. The Director of the Science Advisory Board Staff Office, in consultation with the Chairman of the Science Advisory Board, selected SAB member Dr. A. Myrick Freeman of Bowdoin College, as chair of the Illegal Competitive Advantage (ICA) Economic Benefit (EB) Advisory Panel.

**A.2 Panel Formation**

The panel was formed in accordance with the principles set out in the 2002 commentary of the Science Advisory Board, *Panel Formation Process: Immediate Steps to Improve Policies and Procedures* (EPA-SAB-EC-COM-02-003). A notice offering the public the opportunity to nominate qualified individuals for service on the panel was published in the Federal Register on August 6, 2003 (68 FR 46604) soliciting nominations for Panel membership and can be found on the SAB Web site at: <http://www.epa.gov/sab>, Eleven individuals were considered for membership on the panel. On the basis of candidates' qualifications, interest, and availability, the SAB Staff Office made the decision to put 11 candidates on the "short list" for the panel. On March 26, 2004, the SAB Staff Office posted a notice on the SAB Web site inviting public comments on the prospective candidates for the panel.

The SAB Staff Office Director — in consultation with SAB Staff (including the Designated Federal Officer (DFO) and the Acting SAB Ethics Advisor) and the Chair of the

169 Executive Committee — selected the final panel. Selection criteria included: excellent  
170 qualifications in terms of scientific and technical expertise; the need to maintain a balance with  
171 respect to qualifying expertise, background and perspectives; willingness to serve and availability  
172 to meet during the proposed time periods; and the candidates prior involvement with the topic  
173 under consideration. The final panel includes persons with expertise in one or more of the  
174 following areas:

- 175
- 176 (a) Financial Economics, which includes Corporate Finance,
  - 177 (b) Economic Benefit Recapture Issues,
  - 178 (c) Business/Commercial Damages, which includes Anti-trust Law, Torts, and  
179 Economics,
  - 180 (d) Business Economics and Competitive Strategy, which includes aspects of Statistical  
181 Decision-Making and Game Theory, as well as Competitive Effects of Vertical  
182 Integration and Quantitative Economics, and
  - 183 (e) Industrial Organization, in the context of environmental regulations, and their  
184 enforcement, as well as Environmental and Regulatory Economics, Environmental  
185 Ethics and Sustainability in this context.
- 186

187 The Panel members include individuals who are SAB members or consultants familiar with  
188 the Agency as well as first-time consultants. The final panel determination memo was posted on  
189 July 9, 2004.

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### 192 **A.3 Panel Process and Review Documents**

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194 The Panel first met via conference call on July 12, 2004. The purpose of this public  
195 conference call meeting was to provide background information for the Panelists on the issues in  
196 preparation for the advisory activity. The Panelists a) discussed the charge, review and  
197 background materials provided to the Panel, b) discussed specific charge assignments for the  
198 Panelists, and c) advised the Office of Enforcement and Compliance Assurance (OECA) of any  
199 specific points that need clarification for the August 5 & 6 advisory meeting. Two Panelists were  
200 unable to attend this initial conference call meeting.

201

202 August 5-6, 2004 face-to-face meeting was held in Washington, DC. This also was  
203 a public meeting, and as in the teleconference call, an opportunity was provided for public  
204 comments pursuant to and consistent with the requirements of the Federal Advisory Committee  
205 Act (Public Law 92-463. All but one of the panelists were present at the August 5 & 6, 2004  
206 meeting. The one unable to attend the Washington meeting was available via conference call  
207 hookup.

208  
209 Follow-up conference calls were held on September 22, and November 4, 2004 and  
210 January 19, 2005 to prepare and complete edits to the draft Advisory. At the September 22, 2004  
211 public conference call, the Panel discussed in a public forum, the edits that were needed on its'  
212 internal working draft advisory. The first public draft Advisory dated October 22, 2004 was  
213 shared with the interested public, including the Agency and discussed at the November 4, 2004  
214 public conference call. The second public draft Advisory dated December 15, 2004 was shared  
215 with the interested public, including the Agency for discussions to take place at the January 19,  
216 2005 public conference call. Following the January 19, 2005 public conference call, a March 23,  
217 2005 public draft was prepared and provided to the SAB's Quality Review Committee (QRC),  
218 which met in a public conference call session on April 29, 2005. Subsequent to this public  
219 conference call session, a June 15, 2005 draft was prepared for review by the Board in a public  
220 conference call held on July \_\_, 2005..... All the above drafts were posted onto the SAB Web site  
221 ([www.epa.gov/sab](http://www.epa.gov/sab)) for review by the interested public (including the Agency). — (More details  
222 to follow, as this is completed - - - - KJK)

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**APPENDIX B - BRIEF BIOSKETCHES OF THE ILLEGAL  
COMPETITIVE ADVANTAGE (ICA) ECONOMIC BENEFIT ( EB)  
ADVISORY PANEL**

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**Dr. Dallas Burtraw:**

233 Dr. Burtraw is a Senior Fellow at Resources for the Future. He recently served on the  
234 National Research Council, Committee on Air Quality Management in the United States and  
235 serves as a reviewer, National Energy Modeling System, Energy Information Administration,  
236 (1992-present). Dr. Burtraw's areas of expertise include: air pollution, cost-benefit analysis,  
237 electricity restructuring, regulatory design, and public finance. His research interests include the  
238 restructuring of the electric utility market, the social costs of environmental pollution, benefit-cost  
239 analyses of environmental regulation, and the design of incentive-based environmental policies.  
240 His current projects include the study of integrated approaches to pollutant control in the  
241 electricity sector and the valuation of natural resource improvements in the Adirondacks.  
242 Recently, Dr. Burtraw analyzed the cost-effectiveness of various designs for NO<sub>2</sub> emission trading  
243 in the eastern states and of the design for a carbon emission trading program in the electricity  
244 sector. He also investigated the effects on electric utilities of the sulfur dioxide emissions-permit  
245 trading program legislated under the 1990 Amendments to the Clean Air Act, and evaluated the  
246 benefits of emission reductions resulting from the 1990 Amendments. He holds a Ph.D. in  
247 Economics and a Master in Public Policy from the University of Michigan.

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249  
**Dr. Mark Cohen:**

250 Professor Cohen is Senior Associate Dean and Justin Potter Professor of American  
251 Competitive Business at the Owen Graduate School of Management at Vanderbilt University. He  
252 also serves as Co-Director of the Vanderbilt Center for Environmental Management Studies, and  
253 as Visiting Professor of Criminal Justice Economics at the University of York (UK). He recently  
254 served as Chairman of the American Statistical Association's Committee on Law and Justice  
255 Statistics and is currently a member of the Stakeholder Council of the Global Reporting Initiative.  
256 Prior to his position at Vanderbilt, he had served as senior economist with the U.S. Sentencing  
257 Commission. His work experiences include the Federal Trade Commission, the U.S.  
258 Environmental Protection Agency, the U.S. Department of the Treasury, and the U.S. Senate  
259 Banking Committee. He received his B.S.F.S. in International Economics from Georgetown  
260 University, and his M.A. and Ph.D. in Economics from Carnegie-Mellon University. Professor  
261 Cohen has published over 70 articles on diverse topics such as enforcement of government  
262 regulation, law and economics, white-collar and corporate crime, and environmental management.  
263 Some of his prior work related to the proposed panel include: the costs and benefits of oil spill  
264 enforcement policies; analysis of EPA's penalty policy; optimal penalties for corporate crime  
265 including environmental and antitrust offenses; the public's willingness-to-pay for crime control  
266 policies; why firms comply (and overcomply) with environmental regulations; does it "pay" to be  
267 green; and the effect of disclosure on environmental performance. Research grants over the past  
268 few years include "Measuring Public Perception of Appropriate Prison Sentences" (National  
269 Institute of Justice, 1999) and "Does It Pay to be Green? The Relationship between Environmental  
270 and Financial Performance" (W. Alton Jones Foundation, 1996). In addition he has recently served  
271 as a consultant to two different research projects on corporate environmental performance: (1)  
272 University of Kansas, funded by EPA, and (2)University of Maryland, funded by NIJ.

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**Dr. A. Myrick Freeman III:**

DR. Freeman is Research Professor of Economics at Bowdoin College. In 2000 he retired from teaching after 35 years. Dr. Freeman received his Ph.D. in economics from the University of Washington in 1965. He has been on the faculty at Bowdoin since that time and has served as chair of the economics department and Director of the Environmental Studies Program there. He has also held appointments as Visiting College Professor at the University of Washington and Robert M. La Follette Distinguished Visiting Professor at the University of Wisconsin-Madison and as a Senior Fellow at Resources for the Future, a research organization in Washington, DC.

Dr. Freeman's principal research interests are in the areas of applied welfare economics, benefit-cost analysis, and risk management as applied to environmental and resource management issues. Much of his work has been devoted to the development of models and techniques for estimating the welfare effects of environmental changes such as the benefits of controlling pollution and the damages to natural resources due to releases of chemicals into the environment. He has authored or co-authored eight books including *Air and Water Pollution Control: A Benefit-Cost Assessment*, and *The Measurement of Environmental and Resource Values: Theory and Methods*, now in its second edition. He has also published more than 70 articles and papers in academic journals and edited collections. Dr. Freeman has been a member of the Board on Toxicology and Environmental Health Hazards of the National Academy of Sciences and has served as a member of the Advisory Council on Clean Air Compliance Analysis, the Clean Air Science Advisory Committee and the Environmental Economics Advisory Committee of the U.S. Environmental Protection Agency Science Advisory Board. Most recently, he chaired the EPA SAB Review Panel on UST/RCRA Benefits, Costs, and Impacts Assessment.

**Dr. Jane V. Hall**

Dr. Jane V. Hall is Professor of Economics in the College of Business and Economics and Co-Director of the Institute for Economic and Environmental Studies at California State University, Fullerton. Her current research areas are assessing the value of environmental protection, economics of air pollution policy, natural resource scarcity, and environmental resource scarcity and conflict. She has lectured and conducted research on the topics of energy, sustainability, resource scarcity and conflict, benefit assessment, economic performance and environmental regulation, economic incentives for environmental management and related topics. She has developed positions on air quality standards, fuel composition and taxation, energy policy as an Associate Staff Scientist with the Environmental Defense Fund and as a Special Advisor to the Chair of the California Air Resources Board, and Deputy Assistant for Environmental Protection to the Governor of California. She has also served as an economist with Unocal (Union Oil Company) to assess the impact of federal and state energy policies on the economy and the energy industry. She has published over 100 articles, books or book chapters, working papers and presentations on the above topics. She has served as a member of the Advisory Council on Clean Air Compliance Analysis (COUNCIL), and its Health and Ecological Effects Subcommittee, the EPA's Children's Health Protection Advisory Committee, and a number of other advisory and scientific bodies. She has served as a reviewer for the National Science Foundation, California Air Resources Board Research Division, and for the following publications: *Contemporary Economics Policy*, *Ecological Economics*, *Environmental Science and Technology*, *the Journal of Economics and Environmental Management*, *the Journal of Environment and Development*, and *the National Science Foundation's Science Journal*. Dr. Hall received her B.A. in Economics from the University of Washington, her M.S. in Agricultural and Resource Economics and her Ph.D. in Energy and Resources from the University of California at Berkeley.



323 During the past five years, Dr. Hall has had research funding from the California Air  
324 Resources Board (A Pilot Study to Quantify Health Benefits of Incremental Improvements in Air  
325 Quality; Economic Valuation of Ozone-Related School Absences in the South Coast Air Basin;  
326 and Innovative Clean Air Technology Assessment), the W. Alton Jones Foundation (Growth for  
327 health: the Zero Emission Vehicle and California's Future Prosperity), Sea Grant/NOAA  
328 (Economic Valuation of the Rocky Intertidal Zone), and the U.S. Environmental Protection  
329 Agency and City of Houston (Valuation of Air Pollution and Health).  
330

331 **Dr. W. Michael Hanemann:**

332 Dr. W. Michael Hanemann is Chancellor's Professor in the Department of Agricultural and  
333 Resource Economics and Goldman School of Public Policy at the University of California,  
334 Berkeley. He is Director of the California Climate Change Center at UC Berkeley. Dr. Hanemann's  
335 research interests include non-market valuation, environmental economics and policy, water  
336 pricing and management, demand modeling for market research and policy design, the economics  
337 of climate change, the economics of irreversibility and adaptive management, and welfare  
338 economics. Dr. Hanemann's recent publications have addressed the economic impact of climate  
339 change on US agriculture, fishery management under multiple uncertainty, non-market valuation  
340 using the contingent valuation method, the economic value of reducing asthma, and the economic  
341 theory of willingness to pay and willingness to accept.  
342

343 Dr. Hanemann was educated at Oxford University (B.A.), the London School of  
344 Economics (M. Sc.), Harvard University, (M.A. in Public Finance and Decision Theory and  
345 Harvard University (Ph.D. in Economics). Last October, he was awarded an Honorary Ph.D. by  
346 the Swedish University of Agricultural Sciences. Dr. Hanemann is a member of the California  
347 Bay-Delta Authority Drinking Water Advisory Committee. He served as Chair of the Organizing  
348 Committee for the Second World Congress of Environmental and Resource Economists, held in  
349 Monterey CA in June 2002. In the past 5 years, Dr. Hanemann has received research funding from  
350 the US EPA STAR Grant Program (economic value of childhood asthma, embedding in contingent  
351 valuation); NSF (price and non-price tools for water conservation), NOAA, MMS, the California  
352 State Water Resources Control Board and The California Department of Fish & Game (economic  
353 value of beach recreation in Southern California), and the California Energy Commission (climate  
354 change policy in California).  
355

356 **Dr. Catherine L. Kling:**

357 Dr. Kling is a Professor of Economics at Iowa State University (ISU) and Head of the  
358 Resource and Environmental Policy Division of the Center for Agricultural and Rural  
359 Development at ISU. Prior to coming to Iowa State University in 1993, she was an Associate and  
360 Assistant Professor in the Department of Agricultural Economics at the University of California,  
361 Davis. She has taught graduate and undergraduate courses in environmental economics,  
362 microeconomic theory, and econometrics. Dr. Kling's research encompasses nonmarket valuation  
363 issues in environmental economics and economic incentives for pollution control related especially  
364 to agricultural problems. Her research has been published in a variety of economics journals  
365 including *The Review of Economics and Statistics*, *Journal of Public Economics*, *Journal of*  
366 *Environmental Economics and Management*, *American Journal of Agricultural Economics*, *Land*  
367 *Economics*, *Environmental and Resource Economics*, and *Ecological Economics*.  
368

369 Dr. Kling has also served the profession and the public sector in a variety of capacities  
370 including her current membership on EPA's Environmental Economics Advisory Committee to the  
371 Science Advisory Board. Current and past service includes as a member of the board of directors  
372 and awards committee chair for the American Agricultural Economics Association, vice president

373 and member of the board of directors of the Association of Environmental and Resource  
374 Economists, associate editor for the *American Journal of Agricultural Economics*, and the *Journal*  
375 *of Environmental Economics and Management*, as well as numerous *ad hoc* committees for the  
376 AAEA, AERE, and other professional associations. Dr. Kling's research support has been  
377 provided through grants from the Iowa Department of Natural Resources, the U.S. Environmental  
378 Protection Agency, the U.S. Department of Agriculture, the California Institute for Energy  
379 Efficiency, the Giannini Foundation, and the Sloan Foundation. Dr. Kling holds a B.A. in  
380 Business and Economics from the University of Iowa, and a Ph.D. in Economics from the  
381 University of Maryland.

382  
383 **Dr. Arik Levinson:**

384 Dr. Levinson is an Associate Professor in the Economics Department of Georgetown  
385 University, where he teaches environmental economics, public finance, and microeconomics, and  
386 is Director of Undergraduate Economic Studies. He is a Faculty Research Fellow at the National  
387 Bureau of Economic Research, is on the Editorial Council of the *Journal of Environmental*  
388 *Economics and Management*, and is a member of the American Economic Association, the  
389 Association of Environmental and Resource Economists, and the Association for Public Policy  
390 Analysis and Management. Professor Levinson's research interests include the fields of public  
391 finance and environmental economics. He has studied the theoretical welfare consequences of  
392 states competing to attract manufacturers by enacting successively less stringent environmental  
393 standards (a "race to the bottom"), and measured empirically the effects of interstate differences in  
394 environmental standard stringency on manufacturer location decisions, trade, employment, and  
395 foreign direct investment. Recently, he has written theoretical and empirical papers on the  
396 relationship between countries' environmental quality and their incomes. He has studied the  
397 energy efficiency consequences of apartment leases that include monthly utility costs, and he has  
398 written about the relationship between individuals' willingness to pay for environmental quality,  
399 household income, and national income. His research has in part been funded by the National  
400 Science Foundation, and by the Association for Public Policy Analysis and Management. Dr.  
401 Levinson holds a Ph.D. in Economics from Columbia University.

402  
403 **Dr. Clifford S. Russell:**

404 Dr. Clifford S. Russell is Professor of Economics, Emeritus, Vanderbilt University; and  
405 Research Associate, Bowdoin College. He joined the Vanderbilt faculty as professor of economics  
406 and director of the Institute for Public Policy Studies in January, 1986. Before coming to  
407 Vanderbilt, Dr. Russell was a Senior Fellow and director of the Environmental Quality Research  
408 Division at Resources for the Future in Washington, D.C. During his 17-year tenure there, he held  
409 several other leadership positions. He is the author and editor of 16 books and author or co-author  
410 of 68 articles in environmental economics. His major current interest is in the systematic  
411 examination of environmental labeling as a tool of environmental policy. Dr. Russell has served  
412 as a member of several National Academy of Science committees, and on the Environmental  
413 Studies Board. In 1992/93 he chaired an NAS panel evaluating the U.S. Department of Energy's  
414 proposed system for setting clean-up priorities at contaminated nuclear weapons and research  
415 facilities. He was President of the Association of Environmental and Resource Economists in  
416 1993 and 1994. From December, 1996, to August, 1997, he held the Valfrid Paulsson visiting  
417 chair in environmental economics at the Beijer Institute, part of the Royal Swedish Academy of  
418 Sciences in Stockholm. In 2003 he held the Thomas Sowell Distinguished Visiting Chair of  
419 Economics at Bates College. In the 1970s and '80s Dr. Russell was on the Executive Committee  
420 of the Board of the Environmental Defense Fund (now Environmental Defense). He also served  
421 on the board of the Tennessee Environmental Council. Dr. Russell received his B.A. in  
422 mathematics from Dartmouth College and his Ph.D. from Harvard University, where he was a

423 Harvard Graduate Prize Fellow in Economics. From 1960 through 1963, he served as a  
424 commissioned officer in the U.S. Navy.

425  
426 **Dr. Michael A. Salinger:**

427 Dr. Salinger is Professor of Economics at the Boston University School of Management.  
428 He served as an economist in the Bureau of Economics in the Antitrust Division with the United  
429 States Federal Trade Commission while on leave from Columbia University. At Columbia  
430 University, he served as Associate Professor of Economics and Finance. He also was a Visiting  
431 Associate Professor of Economics at MIT's Sloan School of Management. Dr. Salinger is on the  
432 Editorial Boards of the *Journal of Industrial Economics*, and *Review of Industrial Organization*.  
433 He has published on such topics as the relationship between market structure and corporate  
434 profitability, the competitive effects of business practices (including vertical mergers and  
435 bundling), the statistical properties of firm growth, antitrust policy, and the regulation of  
436 telecommunication prices. His recent research has been funded by the National Science  
437 Foundation and by Microsoft. He has served as a peer reviewer of the BEN model for the EPA.  
438 He received his B.A. in Economics from Yale University and his Ph.D. in Economics from  
439 Massachusetts Institute of Technology.

440  
441 **Dr. David Sunding:**

442 David Sunding is a professor at the University of California at Berkeley in both the College  
443 of Natural Resources and the Boalt Hall School of Law. He received a B.A. in Economics from  
444 Claremont McKenna College in 1983 and his Ph.D. in Agricultural and Resource Economics from  
445 the University of California at Berkeley in 1989. He specializes in environmental policy, natural  
446 resource economics, land use, and law and economics. Prior to his current position, Prof. Sunding  
447 served as a senior economist at the President's Council of Economic Advisers where he had  
448 responsibility for natural resource and environmental policy. He currently serves as member of the  
449 Science Advisory Board of the National Center for Housing and the Environment and is the co-  
450 director of UC Berkeley's Center for Sustainable Resource Development.

451  
452 Professor Sunding is the author of over 50 journal articles and book chapters in the areas of  
453 environmental economics, natural resource economics, and law and economics. He has been  
454 commissioned to write over 30 technical reports and monographs for government and private  
455 interests. Recently, Professor Sunding's research has focused on the measurement of  
456 environmental compliance costs, environmental regulation and processes of urban growth and  
457 development, and the diffusion of conservation technology. Dr. Sunding has had extensive  
458 litigation experience in the areas of compliance cost measurement, environmental remediation and  
459 cost allocation, antitrust and unfair competition, and agricultural and natural resource markets. He  
460 has performed economic and financial analysis relating to damage calculations, market  
461 determination, real property valuation, antitrust and price discrimination and has testified at  
462 deposition and trial. He has recently received grants and/or research funding from the U.S.  
463 Environmental Protection Agency, Food Systems Research Group, California Department of Food  
464 and Agriculture, California Department of Water Resources and U.S. Department of the Interior.

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APPENDIX - C ACRONYMS

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AAEA	American Agricultural Economics Association
ACC	American Chemistry Council
ADV	Advisory
AERE	Association of Environmental Resource Economists
ALJ	Administrative Law Judges (of the U.S. EPA)
BEN	<u>B</u> enefits Calculation Computer Model (to calculate the economic benefit a violator derives from delaying and/or avoiding compliance with environmental statutes)
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CFR	Code of Federal Regulations
COM	Commentary (U.S. EPA/SAB)
COUNCIL	Advisory Council on Clean Air Compliance Analysis (U.S. EPA/SAB/COUNCIL)
CWA	Clean Water Act
DC	District of Columbia
DFO	Designated Federal Officer
DOI	Department of the Interior (U.S. DOI)
EB	Economic Benefit
EC	Executive Committee (of the U.S. EPA/SAB)
EEAC	Environmental Economics Advisory Committee (of the U.S. EPA/SAB)
EPA	Environmental Protection Agency (U.S. EPA)
EPCRA	Emergency Planning and Community Right-to-Know Act

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517	FIFRA	Federal Insecticide, Fungicide and Rodenticide Act
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519	FR	Federal Register
520		
521	FTC	Federal Trade Commission
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523	GM	General Management
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525	ICA	Illegal Competitive Advantage
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527	ISU	Iowa State University
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529	LLC	Limited Liability Corporation
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531	MIT	Massachusetts Institute of Technology
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533	NAS	National Academy of Science
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535	NCEE	National Center for Environmental Economics (U.S. EPA/NCEE)
536		
537	NGO	Non-Government Organization
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539	NIJ	National Institute of Justice
540		
541	NOAA	National Oceanic and Atmospheric Administration (U.S. NOAA)
542		
543	NSF	National Science Foundation
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545	OECA	Office of Enforcement and Compliance Assurance (U.S. EPA/OECA)
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548	OECM	Office of Enforcement and Compliance Monitoring (U.S. EPA/OECM)
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551	OPA	Oil Pollution Act
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553	QRS	Quality Review Subcommittee (U.S. EPA/SAB)
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555	PC	Price-Compliant
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557	PN	Price Non-Compliant
558		
559	QC	Quantity-Compliant
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561	QN	Quantity Non-Compliant
562		
563	QRC	Quality Review Committee
564		
565	QRS	Quality Review Subcommittee

566	RCRA	Resource Conservation and Recovery Act
567		
568	SAB	Science Advisory Board (of the U.S. EPA/SAB)
569		
570	SDWA	Safe Drinking Water Act
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572	TSCA	Toxic Substances Control Act
573		
574	UC	University of California
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576	UK	United Kingdom
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578	USSC	United States Sentencing Commission
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580	USSC	United States Statutory Code
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582	U.S.	United States

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